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GENERAL MOTORS CORPORATION

STRUCTURES II
THE RESPONSE OF A CLAMPED CIRCULAR
PLATE TO IMPULSIVE LOADS

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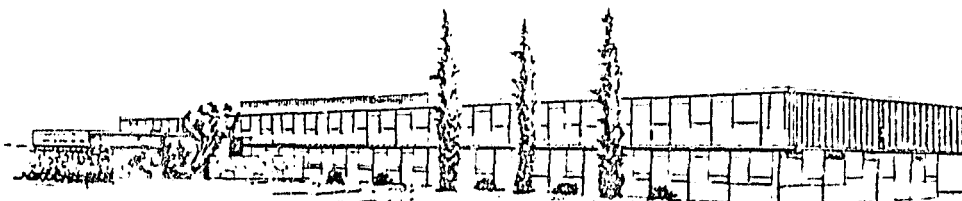
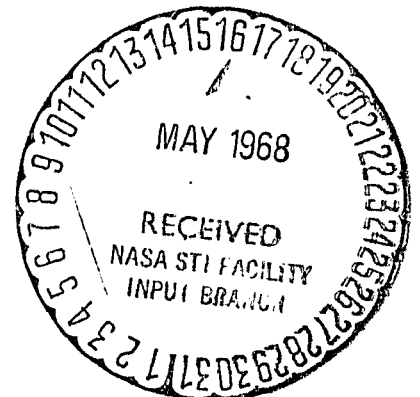
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SANTA BARBARA, CALIFORNIA



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GENERAL MOTORS CORPORATION

STRUCTURES II
THE RESPONSE OF A CLAMPED CIRCULAR
PLATE TO IMPULSIVE LOADS

R.E. Sennott
D.E. Skaar

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ABSTRACT

A computer program describes the response of a clamped circular plate to an axisymmetric impulsive load. An explanation of its use, and a sample problem to illustrate the input and output data formats, as well as various output options, are included.

TR66-63

CONTENTS

Abstract	ii
General Description	1
Input and Initialization	1
Input Format	3
Output	3
Plots	5
Sample Plate Run	5
References	6
Appendix	7
Readout	8
Deformation Profile of an Impact-Loaded Plate	19

TR66-63

PLATE

GENERAL DESCRIPTION

The "Plate" program describes the response of a circular plate, clamped around its circumference, to an axially symmetric impulsive load. The material properties of the plate are idealized as elastic-perfectly plastic, and shear deformation is not included; thus, the (h/R) ratio should be less than 1/10. The Mises flow rule is used for plastic stress calculations from the calculated plastic strains. The plate has 41 mass points equally spaced radially, and six layers through its thickness (Fig. 1). The basic equations are listed in the appendix; the numerical scheme for solving these equations is identical to that of the beam and ring solutions described in Report TR65-08. ^(1,2)

INPUT AND INITIALIZATION

CMT	Classification data (up to 72 characters)
DT	Time interval (sec) This must be smaller than the time required for a longitudinal wave to traverse the distance between mass points; otherwise the solution is unstable.
E	Young's modulus for the plate material (lb/sq in.)
SIGY	Yield stress of material (lb/sq in.)
RAD	Plate radius (in.)
H	Plate thickness (in.)
ZIN	Input displacement (in.) ZIN is the unrestrained displacement of the uniformly loaded portion of the plate during the first time interval (DT).
PNU	Poisson ratio of the plate material
UM	Mass per unit area of plate (lb-sec ² /in. ³)
T	Time (initialized at zero)
TF	Time of termination of solution (sec)

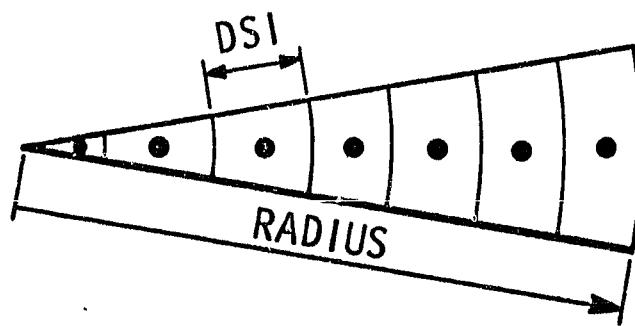
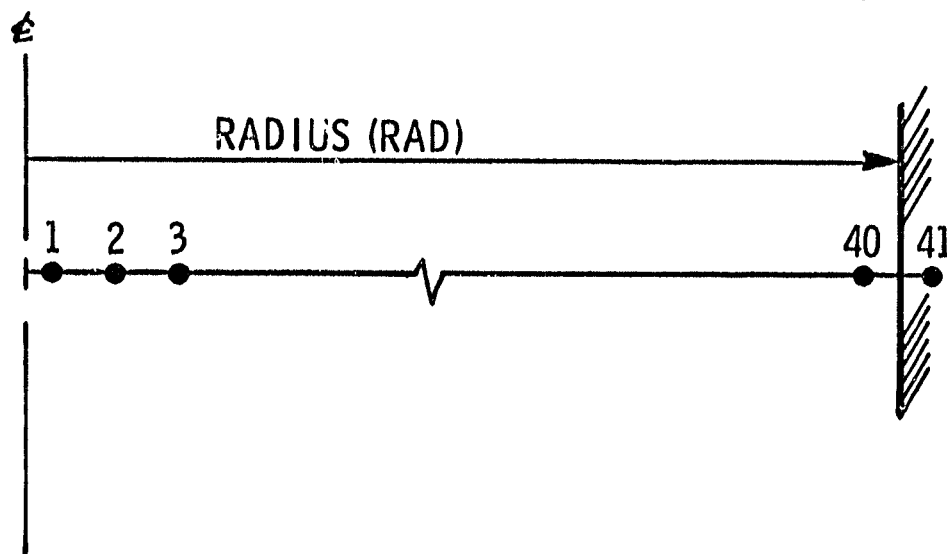


Figure 1 Plate Idealization

TR66-63

TI		Readout time increment (sec)	
TP		Plotting time increment (sec)	
XMIN, XMAX		Minimum and maximum limits of transverse displacement (in.)	
MM		Momentum multiplication factor (used if momentum/unit area is specified as input data)	
fixed point	}	NPL	Total number of plots (set = 0 if no plots are required)
		NZI	Number of last mass point which has non-zero initial displacement
		L1, L2, L3	Mass point numbers at which strains are to be outputted (standard output data)
		NMTM	Number of PMTM inputs
PMTM(I)			Input momentum/unit area for mass points 1 through NMTM (Note: If PMTM is used as input data, NZI must be set equal to NZI+50. This calls a special routine.)

INPUT FORMAT

Figure 2 is a sample of the Plate input format. Cards 2, 3, and 4 are format E14.8; card 5 I2 and the remaining cards, E9.4.

OUTPUT

Standard output data consists of the following at each time increment (TI).

1. All input data (only at first printout)
2. The transverse displacement of the center of the plate
3. The radial and circumferential strains through the thickness for links L1, L2, and L3
4. The radial and circumferential strains at the top and bottom surfaces of the plate at each of the 41 radial links

Supplementary output data can be obtained at each readout time by using sense switches 3 and 4.

TR66-63

If sense switch 3 is on, the additional output is:

1. The radial and transverse accelerations at each of the 41 mass points
2. The radial and transverse displacements at each mass point

If sense switch 4 is on, the additional output is:

1. Radial and transverse normal forces at each link
2. Radial and transverse bending moments at each link (Note: Standard output is written on tape 6; supplementary output on tape 4.)

PLOTS

If NPL is non-zero, plots of the plate profiles at plotting time intervals (TP) are obtained. In addition, a plot of centerline transverse displacement versus time is included automatically when plots are obtained. This must be accounted for when specifying the total number of plots.

SAMPLE PLATE RUN

The response of a clamped circular plate to an impulsive load (given by specifying the momentum per unit area over the loaded portion of the plate) is desired.

The plate material is 7075-T6 aluminum, 0.240 in. thick with a radius of 4 inches. The response for 40 μ sec is requested, with data printout every 10 μ sec. A time increment (ΔT) of 0.4 μ sec satisfies the stability criterion.

The output data for this sample problem, as well as plots of the plate profile at 40.3 μ sec and the centerline displacement-time curve, are included in the appendix.

TR66-63

REFERENCES

1. E. A. Witmer, et al., "Large Dynamic Deformations of Beams, Circular Rings, Circular Plates, and Shells" (AIAA Launch and Space Vehicle Shell Structures Conference, Apr 1-3, 1963, Palm Springs, Calif.)
2. R. E. Sennett, D. E. Skaar, "Structures I—The Response of Beams and Rings to High-Intensity Short-Duration Loading," GM Defense Research Laboratories, TR65-08, 1965

APPENDIX

BASIC EQUATIONS

Dynamic Equilibrium:

$$\frac{\partial}{\partial s} [N_{\theta} r \cos \theta] - \frac{\partial}{\partial s} [Q_{\theta} r \sin \theta] - N_{\varphi} - m r r = 0$$

$$\frac{\partial}{\partial s} [N_{\theta} r \sin \theta] + \frac{\partial}{\partial s} [Q_{\theta} r \cos \theta] - m r z = 0$$

$$\frac{\partial}{\partial s} [M_{\theta} r] - M_{\varphi} \cos \theta - Q_{\theta} r = 0$$

Stress Strain:

$$\sigma_{\theta} = \frac{E}{1-\nu^2} [e_{\theta} + \nu e_{\varphi}]$$

$$\sigma_{\varphi} = \frac{E}{1-\nu^2} [e_{\varphi} + \nu e_{\theta}]$$

Flow Rule (plane stress):

$$\sigma_{\varphi}^2 - \sigma_{\varphi} \sigma_{\theta} + \sigma_{\theta}^2 = \sigma_y^2$$

DATE

FORTRAN SOURCE LIST

```

ISN      SOURCE STATEMENT
0 $IBFTC PLATE FULIST,REF
1      COMMON R(41),RO(41),R1(41),RF(41),RE(41),Z(41),ZO(41),Z1(41),
1      1 DSIB(41),DSI(41),SM(41),S(41),C(41),DSIBO(41),ET1(41),DTH(41),
2      2 PSI(6),ET(1,6),ETT(41,6),EP1(41),PCUR(41),EP2(41,6),
3      3 EPT(41,6),SIGTH(41,6),SIGPH(41,6),FNORT(41),FNORP(41),
4      4 BMOMT(41),BMOMP(41),Q(41),ZUD(41),RDD(41),ZIT(41),RIT(41),
5      5 ETTT(41,6),EPTT(41,6),DET(41,6),DEP(41,6),SGTHT(41,6),
6      6SGPHT(41,6),PHIT(41,6),CMT(12),PMTM(41),
7      7 TIMX(500),CLDS(500),XMIN,XMAX,RAD,TP,TG,T,TF,INP,IPSA
2      COMMON /MODIF/ DSIO,UM,LC,L1,L2,L3,NZI,DT,NMTM
3      REAL MM
4      DIMENSION DATA(800)
5      498 FORMAT (1H ,I2,4X,E14.8,2X,E14.8,2X,E14.8,2X,E14.8)
6      499 FORMAT (8E9.4)
7      500 FORMAT (5E14.8)
10     501 FORMAT (6I2)
11     502 FORMAT (12A6)
12     510 FORMAT (50H1 DEFORMATION PROFILE OF AN IMPACT LOADED PLATE,41X,
1      1 A2,1H/,A2,1H/,A2,6X5HPAGE ,I3/5X12A6)
13     511 FORMAT (1H0,8X,4HDT =,E15.8,3X,3HE =,E15.8,3X,6HSIGY =,E15.8,3X,
1      1 5HRAD =,E15.8/9X,4HTI =,E15.8,3X,3HH =,E15.8,3X6HZIN =,E15.8,
2      2 3X,5HPNU =,E15.8,/9X,4HTP =,E15.8,3X,3HT =,E15.8,3X,6HTF =,
3      3 E15.8,3X,5HUM =,E15.8)
14     512 FORMAT (9X,47HINITIAL DISPLACEMENT EXTENDS FROM MASS POINT 1 ,
1      1 14HTO MASS POINT ,I2)
15     513 FORMAT (7HOLINE 1,7X,4HTIME,14X,7HCLDISP./9H LINE 2 J,
1      1 3(5X,5HEPTT(,I2,3H,J),3X),3(5X,5HETTT(,I2,3H,J),3X)/6HO LINE)
16     514 FORMAT (5HO 1,4X,2E18.8)
17     515 FORMAT (5H 2,3XI1,6E18.8)
20     516 FORMAT (5HO 1,4X,2E18.8,3X11H(CONTINUED))
21     517 FORMAT (1H0,9X5HTIME=,E14.8/27X5HFNORT,15X5HFNORP,15X5HBMOMT,
1      1 15X5HBMOMP,41(/18XI2,4E20.8,5XI2))
22     518 FORMAT (1H0,9X5HTIME=,E14.8/27X3HZDD,17X3HRDD,17X3HZIT,17X3HRIT,
1      1 41(/18XI2,4E20.8,5XI2))
23     519 FORMAT (1H0,8X,4HDT =,E15.8,3X,3HE =,E15.8,3X,6HSIGY =,E15.8,3X,
1      1 5HRAD =,E15.8/9X,4HTI =,E15.8,3X,3HH =,E15.8,3X6HUM =,E15.8,
2      2 3X,5HPNU =,E15.8,/9X,4HTP =,E15.8,3X,3HT =,E15.8,3X,6HTF =,
3      3 E15.8)
24     CALL PLOTS (DATA,800)
25     CALL PLOT (8.5,10.,-3)
26     CALL DATE (ID1,ID2,ID3)
27     NPGN=1
30     NPGA=1
31     TEST=2.**(-26)
32     CALL FPT (.TRUE.,0)
33     CALL SSWTCH (3,JSS)
34     CALL SSWTCH (4,ISS)
35     1 READ (5,502) CMT
36     WRITE (6,510) ID1,ID2,ID3,NPGN,CMT
37     READ (5,500) DT,E,SIGY,RAD,H,ZIN,PNU,UM,T,TF,TI,TP,XMIN,XMAX,MM
40     READ (5,501) NPL,NZI,L1,L2,L3,NMTM
47     READ (5,499) (PMTM(I),I=1,NMTM)
54     UM=UM*H
C IF NZI .GT. 50 THE SPECIAL ROUTINE WILL BE CALLED AND NZI WILL BE NZI-50.
55     IPSA=1

```

PLATE

FORTRAN SOURCE LIST PLATE

ISN	SOURCE STATEMENT
56	IF (NZI.LE.50) GO TO 2
61	IPSA=2
62	NZI=NZI-50
63	WRITE (6,519) DT,E,SIGY,RAD,TI,H,UM,PNU,TP,T,TF
64	NPGN=NPGN+1
65	GO TO 101
66	2 WRITE (6,511) DT,E,SIGY,RAD,TI,H,ZIN,PNU,TP,T,TF,UM
67	WRITE (6,512) NZI
70	WRITE (6,513) L1,L2,L3,L1,L2,L3
71	NPGN=NPGN+1
72	LC=12
73	101 TG=TP
74	INP=0
75	DSIO=RAD/40.
76	DO 3 I=1,41
77	FI=I
100	R(I)=(FI-.5)*DSIO
101	RO(I)=R(I)
102	R1(I)=RO(I)
103	3 RF(I)=R(I)
105	DO 4 I=1,40
106	4 RE(I+1)=(R(I+1)+R(I))/2.
110	RE(1)=0.0
111	GO TO (103,102),IPSA
112	102 CALL MODZ (MM)
113	GO TO 104
114	103 DO 5 I=1,NZI
115	5 Z(I)=ZIN
117	104 NMI=NZI+1
120	DO 6 I=NMI,41
121	6 Z(I)=0.0
123	DO 602 I=1,41
124	ZO(I)=0.
125	602 Z1(I)=Z(I)
127	DO 7 I=1,40
130	7 DSIB(I+1)=SQRT((ABS(Z(I+1)-Z(I)))**2+(ABS(R(I+1)-R(I)))**2)
132	DSIB(1)=2.*R(1)
133	DO 8 I=1,40
134	8 DSI(I)=(DSIB(I+1)+DSIB(I))/2.
136	DSI(41)=DSIO
137	DO 46 I=1,41
140	46 SM(I)=UM*R(I)*DSIO
142	DO 10 I=1,39
143	S(I+1)=(Z(I+1)-Z(I))/DSIB(I+1)
144	10 C(I+1)=(R(I+1)-R(I))/DSIB(I+1)
146	S(41)=0.
147	S(1)=0.0
150	C(41)=1.
151	C(1)=1.
152	DO 12 I=1,41
153	DSIBO(I)=DSIO
154	DIFE=ABS(DSIB(I)-DSIBO(I))
155	IF (DIFE.LE.TEST) GO TO 120
160	ET1(I)=(DSIB(I)-DSIBO(I))/DSIBO(I)
161	GO TO 12

PLATE

FORTRAN SOURCE LIST PLATE

PLATE	ISN	SOURCE STATEMENT
	162	120 ET1(I)=0.0
	163	12 CONTINUE
	165	DO 13 I=1,40
	166	13 DTH(I+1)=S(I+1)*C(I)-C(I+1)*S(I)
	170	DTH(1)=0.
	171	DO 14 J=1,6
	172	FJ=J
	173	14 PSI(J)=(H/6.)*(FJ-3.5)
	175	DO 15 I=1,41
	176	DO 15 J=1,6
	177	15 ET2(I,J)=-PSI(J)*(DTH(I)/DSIB(I))
	202	DO 17 I=1,40
	203	DO 17 J=1,6
	204	17 ETT(I,J)=ET1(I)+ET2(I+1,J)
	207	DO 171 J=1,6
	210	171 ETT(41,J)=ETT(40,J)
	212	DO 18 I=1,41
	213	18 EP1(I)=(R(I)/RO(I))-1.
	215	DO 19 I=2,41
	216	19 PCUR(I)=S(I)/RE(I)
	220	PCUR(1)=0.
	221	DO 24 I=1,41
	222	DO 23 J=1,6
	223	EP2(I,J)=-PSI(J)*PCUR(I)
	224	EPT(I,J)=EP1(I)+EP2(I,J)
	225	SIGTH(I,J)=(E/(1.-PNU**2))*(ETT(I,J)+PNU*EPT(I,J))
	226	IF (ABS(SIGTH(I,J)).GT.SIGY) SIGTH(I,J)=SIGN(SIGY,SIGTH(I,J))
	231	SIGPH(I,J)=(E/(1.-PNU**2))*(EPT(I,J)+PNU*ETT(I,J))
	232	IF (ABS(SIGPH(I,J)).GT.SIGY) SIGPH(I,J)=SIGN(SIGY,SIGPH(I,J))
	235	23 CONTINUE
	237	24 CONTINUE
	241	TC=0.
	242	80 CONTINUE
	243	DO 44 I=1,41
	244	FNORT(I)=0.
	245	FNORP(I)=0.
	246	BMOMT(I)=0.
	247	BMOMP(I)=0.
	250	DO 43 J=1,6
	251	FNORT(I)=(H/6.)*SIGTH(I,J)+FNORT(I)
	252	FNORP(I)=(H/6.)*SIGPH(I,J)+FNORP(I)
	253	BMOMT(I)=SIGTH(I,J)*(H/6.)*PSI(J)+BMOMT(I)
	254	43 BMOMP(I)=SIGPH(I,J)*(H/6.)*PSI(J)+BMOMP(I)
	256	44 CONTINUE
	260	DO 45 I=1,40
	261	45 Q(I+1)=(BMOMT(I+1)*R(I+1)-BMOMT(I)*R(I)-BMOMP(I+1)*DSIB(I+1)*C(I+1)) / (RE(I+1)*DSIB(I+1))
	263	Q(1)=0.
	264	DO 48 I=1,40
	265	ZDD(I)=(FNORT(I+1)*RE(I+1)*S(I+1)-FNORT(I)*RE(I)*S(I)+Q(I+1)*RE(I+1)*C(I+1)-Q(I)*RE(I)*C(I))/SM(I)
	266	48 RDD(I)=(FNORT(I+1)*RE(I+1)*C(I+1)-FNORT(I)*RE(I)*C(I)-Q(I+1)*RE(I+1)*S(I+1)+Q(I)*RE(I)*S(I)-FNORP(I)*DSI(I))/SM(I)
	270	ZDD(41)=0.
	271	RDD(1)=0.

PLATE

FORTRAN SOURCE LIST PLATE

ISN	SOURCE STATEMENT
272	RDD(41)=0.
273	DO 49 I=1,41
274	49 ZIT(I)=ZDO(I)*DT**2+2.*Z1(I)-ZO(I)
276	ZIT(40)=0.
277	ZIT(41)=0.
300	DO 54 I=1,41
301	ZO(I)=Z1(I)
302	Z1(I)=ZIT(I)
303	RIT(I)=RDD(I)*DT**2+2.*R1(I)-RO(I)
304	RO(I)=R1(I)
305	R1(I)=RIT(I)
306	54 R(I)=RIT(I)
310	DO 55 I=1,40
311	55 RE(I+1)=(RIT(I+1)+RIT(I))/2.
313	RE(1)=0.
314	DO 56 I=1,40
315	56 DSIB(I+1)=SQRT((ABS(ZIT(I+1)-ZIT(I)))**2+(ABS(RIT(I+1)-RIT(I)))**2 1)
317	DSIB(1)=2.*RIT(1)
320	DO 57 I=1,40
321	57 DSI(I)=(DSIB(I+1)+DSIB(I))/2.
323	DSI(41)=DSIO
324	DO 59 I=1,39
325	S(I+1)=(ZIT(I+1)-ZIT(I))/DSIB(I+1)
326	59 C(I+1)=(RIT(I+1)-RIT(I))/DSIB(I+1)
330	S(41)=0.
331	S(1)=0.
332	C(41)=1.
333	C(1)=1.
334	DO 60 I=1,41
335	DIFE=ABS(DSIB(I)-DSIBO(I))
336	IF (DIFE.LE.TEST) GO TO 121
341	ET1(I)=(DSIB(I)-DSIBO(I))/DSIBO(I)
342	GO TO 60
343	121 ET1(I)=0.0
344	60 CONTINUE
346	DO 61 I=1,40
347	61 DTH(I+1)=S(I+1)*C(I)-C(I+1)*S(I)
351	DTH(1)=0.
352	DO 62 I=1,41
353	DO 62 J=1,6
354	62 ET2(I,J)=-PSI(J)*(DTH(I)/DSIBO(I))
357	DO 64 I=1,40
360	DO 64 J=1,6
361	64 ETTT(I,J)=ET1(I)+ET2(I+1,J)
364	DO 641 J=1,6
365	641 ETTT(41,J)=ETTT(40,J)
367	DO 65 I=1,41
370	65 EP1(I)=(RIT(I)/RF(I))-1.
372	DO 66 I=2,41
373	66 PCUR(I)=S(I)/RE(I)
375	PCUR(1)=0.
376	DO 74 I=1,41
377	DO 73 J=1,6
400	EP2(I,J)=-PSI(J)*PCUR(I)

PLATE	ISN	SOURCE STATEMENT	FORTRAN SOURCE LIST PLATE
	401	EPTT(I,J)=EP1(I)+EP2(I,J)	
	402	DET(I,J)=ETTT(I,J)-ETT(I,J)	
	403	ETT(I,J)=ETTT(I,J)	
	404	DEP(I,J)=EPTT(I,J)-EPT(I,J)	
	405	EPT(I,J)=EPTT(I,J)	
	406	SGTHT(I,J)=SIGTH(I,J)+(E/(1.-PNU**2))*(DET(I,J)+PNU*DEP(I,J))	
	407	73 SGPHT(I,J)=SIGPH(I,J)+(E/(1.-PNU**2))*(DEP(I,J)+PNU*DET(I,J))	
	411	74 CONTINUE	
	413	COM=(2.0*SIGY**2)/3.	
	414	DO 76 I=1,41	
	415	DO 75 J=1,6	
	416	CS=(SGTHT(I,J)+SGPHT(I,J))/3.	
	417	SGTP=SGTHT(I,J)-CS	
	420	SGPP=SGPHT(I,J)-CS	
	421	SIGTH(I,J)=SGTHT(I,J)	
	422	SIGPH(I,J)=SGPHT(I,J)	
	423	PHIT(I,J)=SGTP**2+SGPP**2+CS**2	
	424	IF (PHIT(I,J).LE.COM) GO TO 75	
	427	CON=SQRT(COM/PHIT(I,J))	
	430	SGTP=CON*SGTP	
	431	SGPP=CON*SGPP	
	432	CS=CON*CS	
	433	SIGTH(I,J)=SGTP+CS	
	434	SIGPH(I,J)=SGPP+CS	
	435	75 CONTINUE	
	437	76 CONTINUE	
	441	IF (NPL.EQ.0) GO TO 79	
	444	IF (TG.GT.T) GO TO 79	
	447	CALL GRHP	
	450	79 IF (T.GE.TC) GO TO 82	
	453	81 IF (TF.LE.T) GO TO 1	
	456	T=T+DT	
	457	GO TO 80	
	460	82 IPGE=1	
	461	LC=LC+3	
	462	IF (LC.GE.54) GO TO 86	
	465	LC=LC-1	
	466	83 WRITE (6,514) T,ZIT(1)	
	467	IPGE=2	
	470	DO 85 J=1,6	
	471	LC=LC+1	
	472	IF (LC.GE.54) GO TO 86	
	475	84 WRITE (6,515) J,EPTT(L1,J),EPTT(L2,J),EPTT(L3,J),ETTT(L1,J), 1 ETTT(L2,J),ETTT(L3,J)	
	476	85 CONTINUE	
	500	WRITE(6,498) (I,EPTT(I,1),EPTT(I,6),ETTT(I,1),ETTT(I,6),I=1,41)	
	505	TC=TC+TI	
	506	INP=INP+1	
	507	TIMX(INP)=T	
	510	CLDS(INP)=ZIT(1)	
	511	IF (ISS.EQ.1) GO TO 88	
	514	IF (JSS.EQ.1) GO TO 89	
	517	GO TO 81	
	520	86 WRITE (6,510) ID1,ID2,ID3,NPGN,CMT	
	521	WRITE (6,513) L1,L2,L3,L1,L2,L3	

PLATE

FORTRAN SOURCE LIST PLATE

ISN	SOURCE STATEMENT
522	NPGN=NPGN+1
523	LC=7
524	GO TO (83,87),IPGE
525	87 WRITE (6,516) T,ZIT(1)
526	GO TO 84
527	88 WRITE (4,510) ID1,ID2,ID3,NPGA,CMT
530	WRITE (4,517) T,(I,FNORT(I),FNORP(I),BMOMT(I),BMOMP(I),I,I=1,41)
535	NPGA=NPGA+1
536	IF (JSS.EQ.2) GO TO 81
541	89 WRITE (4,510) ID1,ID2,ID3,NPGA,CMT
542	WRITE (4,518) T,(I,ZOD(I),ROD(I),ZIT(I),RIT(I),I,I=1,41)
547	NPGA=NPGA+1
550	GO TO 81
551	END

PLATE FORTRAN SOURCE LIST

```

0 $IBFTC GRHP LIST
1 SUBROUTINE GRHP
2 COMMON R(41),RO(41),RI(41),RF(41),RE(41),Z(41),ZO(41),ZI(41),
1 DSIB(41),DSI(41),SM(41),S(41),C(41),DSIBO(41),ET1(41),DTH(41),
2 PSI(6),ET2(41,6),ETT(41,6),EP1(41),PCUR(41),EP2(41,6),
3 EPT(41,6),SIGTH(41,6),SIGPH(41,6),FNORT(41),FNORP(41),
4 BMOMT(41),BMOMP(41),Q(41),ZDD(41),RDD(41),ZIT(41),RIT(41),
5 ETTT(41,6),EPTT(41,6),DET(41,6),DEP(41,6),SGTHT(41,6),
6SGPHT(41,6),PHIT(41,6),CMT(12),PMTM(41),
7 TIMX(500),CLDS(500),XMIN,XMAX,RAD,TP,TG,T,TF,INP,IPSA
3 DIMENSION X(40),Y(40)
4 DX=(XMAX-XMIN)/7.0
5 DY= RAD/10.
6 DO 2 I=1,40
7 X(I)=- (ZIT(I)-XMIN)/DX
10 2 Y(I)=- (RIT(I))/DY
12 CALL AXIS (0.0,0.0,21HDISPLACEMENT (INCHES),-21,7.0,180.,XMIN,DX)
13 CALL AXIS (0.0,0.0,28HPOSITION COORDINATE (INCHES),+28,10.0,270.,
1 0.0,DY)
14 CALL LINE (X,Y,40,1)
15 CALL SYMBOL (-4.98,-7.02,0.14,7HTIME = ,270.,7)
16 TIME=T*10.**6
17 CALL NUMBER (-4.98,-7.86,0.14,TIME,270.,1)
20 CALL PMUY (-4.98,-8.70, 0.14)
21 CALL SYMBOL (-4.98,-8.82,0.14,4HSEC.,270.,4)
22 TG=TG+TP
23 IF (TG.GT.TF) GO TO 3
26 CALL PLOT (8.5,0.0,-3)
27 RETURN
30 3 CALL PLOT (1.5,-2.,-3)
31 INP=INP+1
32 TIMX(INP)=T
33 CLDS(INP)=ZIT(1)
34 CALL SCALE (TIMX,INP,6.0,YMIN,DY,1)
35 CALL SCALE (CLDS,INP,8.0,XMIN,DX,1)
36 CALL AXIS (0.0,0.0,4HTIME,-4,6.0,270.,YMIN,DY)
37 CALL AXIS (0.0,0.0,24HCENTER LINE DISPLACEMENT, 24,8.0,0.0,XMIN,
1 DX)
40 DO 4 I=1,INP
41 4 TIMX(I)=-TIMX(I)
43 CALL LINE (CLDS,TIMX,INP,1)
44 CALL PLOT (8.5,2.,-3)
45 CALL SYMBOL (0.02,-.07,0.21,45HDEFORMATION PROFILE OF AN IMPACT LO
1ADED PLATE,270.,45)
46 CALL PLOT (8.5,0.0,-3)
47 RETURN
50 END

```


1	0.10399999E-04	C. 37322712E-01	-0.26450575E-01	-0.56973735E-01	0.54827025E-02	-0.20330711E-01
2	0.	-G. 56408227E-01	-0.15668565E-01	-0.34184241E-01	0.42663405E-02	-C. 11435730E-01
2	0.	-0.33627999E-01	-0.48866595E-02	-0.11394747E-01	0.30499784E-02	-0.25414495E-02
2	0.	-0.10847771E-01	-0.58952550E-02	0.11394747E-01	0.13336164E-02	C. 63528313E-02
2	0.	C. 11932437E-01	0.16677165E-01	0.34184241E-01	0.61725435E-03	0.15247112E-01
2	0.	0.34712685E-01	0.27459075E-01	0.56973735E-01	-0.59910768E-03	0.24141393E-01
2	0.	0.57492913E-01	0.56973735E-01	0.56973735E-01		
3	0.	0.56973735E-01	0.56973735E-01	0.56973735E-01		
2	0.56408227E-01	0.57492913E-01	0.54827025E-02	0.59910768E-03		
3	0.26450475E-01	0.27459075E-01	0.20330711E-01	0.24141393E-01		
4	0.25598198E-01	0.25149450E-01	0.10185444E-01	0.84687955E-02		
5	0.17127784E-01	0.16295391E-01	0.57742695E-02	0.44738282E-02		
6	0.12765611E-01	0.11730591E-01	0.29536436E-01	0.27729484E-01		
7	0.58472145E-02	0.50268609E-02	0.82690016E-02	0.68445438E-02		
8	0.39070435E-02	0.32537319E-02	0.24136854E-01	0.23076282E-01		
9	0.41818896E-03	0.56234210E-04	0.21064987E-02	0.29758697E-02		
10	0.62683688E-03	0.25970205E-03	0.12469145E-01	0.11908415E-01		
11	0.67184657E-03	0.96850779E-03	0.12351907E-01	0.12791715E-01		
12	0.52280298E-03	0.27215055E-03	0.81799094E-02	0.79281457E-02		
13	0.21146174E-03	0.40234561E-03	0.66098440E-02	0.85485061E-02		
14	0.31893329E-03	0.17071141E-03	0.89438525E-02	0.71197990E-02		
15	0.34165997E-03	0.45322496E-03	0.12786959E-01	0.13201062E-01		
16	0.53674509E-03	0.45402874E-03	0.10936942E-01	0.10546271E-01		
17	0.17764512E-03	0.23628119E-03	0.35196565E-03	0.67781680E-03		
18	0.14276526E-03	0.18623195E-03	0.62927980E-02	0.65073189E-02		
19	0.21596647E-03	0.18445051E-03	0.60915484E-02	0.59010557E-02		
20	0.11305574E-03	0.13880495E-03	0.64797645E-02	0.65667314E-02		
21	0.21557915E-03	0.19748914E-03	0.89259283E-02	0.87786666E-02		
22	0.21853198E-03	0.23112346E-03	0.10644424E-01	0.10766728E-01		
23	0.27840426E-03	0.26563396E-03	0.10175357E-01	0.10156358E-01		
24	0.17681048E-03	0.18680916E-03	0.95820493E-02	0.96518799E-02		
25	0.23045017E-03	0.22250785E-03	0.13940762E-01	0.13870205E-01		
26	0.33474663E-03	0.34288267E-03	0.15212468E-01	0.15270993E-01		
27	0.26383131E-03	0.25708108E-03	0.11329595E-01	0.11255239E-01		
28	0.16411294E-03	0.17075886E-03	0.62617763E-02	0.62785029E-02		
29	0.65429569E-04	0.59528709E-04	0.66677512E-02	0.66505217E-02		
30	0.16717890E-03	0.17142573E-03	0.13736193E-01	0.13803695E-01		
31	0.29715324E-03	0.29354716E-03	0.14470602E-01	0.14376724E-01		
32	0.17874623E-03	0.18019164E-03	0.75224217E-02	0.76176401E-02		
33	0.62525681E-04	0.62883309E-04	0.57701259E-02	0.57090125E-02		
34	0.11480637E-03	0.11143871E-03	0.11085336E-01	0.11200466E-01		
35	0.21555677E-03	0.22032514E-03	0.13283077E-01	0.13177037E-01		
36	0.17019886E-03	0.16239066E-03	0.80311642E-02	0.81787602E-02		
37	0.58307276E-04	0.68618880E-04	0.76183307E-02	0.75142834E-02		
38	0.14851385E-03	0.13698035E-03	0.10404709E-01	0.10488509E-01		
39	0.12905287E-03	0.14279174E-03	0.58840785E-02	0.57609577E-02		
40	0.23816364E-04	0.98986795E-05	0.64657005E-03	0.66832575E-03		
41	0.	0.	0.64657005E-03	0.66832575E-03		
1	0.20399997E-04	0.48144829E-01	0.49126367E-01	0.49126367E-01	0.18743374E-02	-0.23414642E-01
2	0.	-0.48153245E-01	-0.25791077E-01	-0.29475820E-01	-0.77229633E-04	-0.13045650E-01
2	0.	-0.28516522E-01	-0.43665824E-02	-0.98252733E-02	0.17198781E-02	-0.26766584E-02
2	0.	-0.88797975E-02	0.63456652E-02	0.98252733E-02	0.35169859E-02	0.76923334E-02
2	0.	0.10756927E-01	0.17057913E-01	0.29475820E-01	0.53140937E-02	0.18061325E-01
2	0.	0.30393651E-01	0.27770160E-01	0.49126367E-01	0.71112015E-02	0.28430317E-01
2	0.	0.50030374E-01	0.49126367E-01	0.49126367E-01		
1	0.48153245E-01	0.50030374E-01	0.18743374E-02	0.71112015E-02		
2	0.25791077E-01	0.27770160E-01	0.23414642E-01	0.28430317E-01		
3	0.26439195E-01	0.26524578E-01	0.48775897E-02	0.31939623E-02		
4	0.19171065E-01	0.18563053E-01	0.12064771E-02	0.38809748E-02		
5	0.16193453E-01	0.15018094E-01	0.25091962E-01	0.22720945E-01		
6	0.96261511E-02	0.84302435E-02	0.83425635E-02	0.67162508E-02		
7	0.72322053E-02	0.60947401E-02	0.25564276E-01	0.24145946E-01		
8	0.31927655E-02	0.22537092E-02	0.14566027E-02	0.4319049E-03		
9	0.27072002E-02	0.19236673E-02	0.18575088E-01	0.17402394E-01		

11	0.58881976E-03	0.40277460E-04	0.43993156E-02	0.5246212E-02	0.5246212E-02	-0.5275082E-02
12	0.94633742E-03	0.42926712E-03	0.11902221E-01	C.11185586E-01	C.11185586E-01	-0.21839050E-02
13	0.11576464E-03	0.54779401E-03	0.56972216E-02	C.61689208E-02	C.61689208E-02	0.90719816E-03
14	0.33172739E-03	0.38179034E-04	0.16473395E-01	0.10063672E-01	0.10063672E-01	0.39983013E-02
15	0.43935275E-03	0.75522756E-03	0.13649421E-01	0.14132889E-01	0.14132889E-01	0.56841714E-02
16	0.51131528E-03	0.22624117E-03	0.12287076E-01	0.12095074E-01	0.12095074E-01	9.11985729E-01
17	0.28995016E-03	0.54271855E-03	0.84424390E-02	0.87349291E-02	0.87349291E-02	0.70896046E-02
18	0.22732416E-03	0.44009266E-06	0.71487273E-02	0.69603579E-02	0.69603579E-02	0.10180508E-01
19	0.18516552E-03	0.38448345E-03	0.12230313E-01	C.12547256E-01	C.12547256E-01	0.18287286E-01
20	0.47202424E-03	0.29295698E-03	0.12795733E-01	C.12547256E-01	C.12547256E-01	0.13220500E-01
21	0.19078051E-03	0.34977590E-03	0.11826218E-01	0.12087771E-01	0.12087771E-01	0.61738399E-01
22	0.38181008E-03	0.24224580E-03	0.10405767E-01	0.10194279E-01	0.10194279E-01	0.14816340E-01
23	0.10726645E-03	0.22939636E-03	0.10045054E-01	0.10311375E-01	0.10311375E-01	0.94879549E-02
24	0.33273553E-03	0.23036455E-03	0.11170259E-01	C.10786312E-01	C.10786312E-01	0.14065844E-01
25	0.14561902E-03	0.22966157E-03	0.72838016E-02	C.76514505E-02	C.76514505E-02	0.70970799E-02
26	0.15072693E-03	0.86443318E-04	0.73768120E-02	C.69485154E-02	C.69485154E-02	0.82178029E-02
27	0.13702060E-03	0.18592621E-03	0.91271233E-02	C.94879549E-02	C.94879549E-02	0.12383995E-01
28	0.20710933E-03	0.17137635E-03	0.14346289E-01	C.14006785E-01	C.14006785E-01	0.14816340E-01
29	0.31268748E-03	0.33499451E-03	0.13636839E-01	C.14065844E-01	C.14065844E-01	0.92087631E-02
30	0.17172499E-03	0.15822453E-03	0.73576640E-02	C.70970799E-02	C.70970799E-02	0.68942876E-02
31	0.83049156E-04	0.79830505E-04	0.77148514E-02	0.82178029E-02	0.82178029E-02	0.12786742E-01
32	0.16958350E-03	0.18674964E-03	0.12856641E-01	0.12383995E-01	0.12383995E-01	0.11708644E-01
33	0.23551440E-03	0.20806646E-03	0.14414419E-01	0.14816340E-01	0.14816340E-01	0.11708644E-01
34	0.21070524E-03	0.24494811E-03	0.95202905E-02	0.92087631E-02	0.92087631E-02	0.54908242E-02
35	0.75622384E-04	0.32975262E-04	0.65667601E-02	C.68942876E-02	C.68942876E-02	0.17947957E-02
36	0.11296608E-03	0.16613343E-03	0.13227127E-01	0.12786742E-01	0.12786742E-01	0.18170170E-02
37	0.25587721E-03	0.19537850E-03	0.11322107E-01	0.11708644E-01	0.11708644E-01	0.17947957E-02
38	0.57895833E-04	0.12548750E-03	0.71989254E-02	C.68608926E-02	C.68608926E-02	0.17947957E-02
39	0.12970346E-03	0.61724367E-04	0.53954568E-02	C.17947957E-02	C.17947957E-02	0.17947957E-02
40	0.12925131E-04	0.79682332E-04	0.18170170E-02	C.17947957E-02	C.17947957E-02	0.17947957E-02
41	0.	0.	0.18170170E-02	0.17947957E-02	0.17947957E-02	0.17947957E-02
1	0.30399994E-04	0.53498431E-01	0.41508579E-01	-0.41508579E-01	-0.41508579E-01	-0.41508579E-01
2	0.	-0.40361053E-01	-0.27600894E-01	-0.27600894E-01	-0.27600894E-01	-0.27600894E-01
3	0.	-0.23771469E-01	-0.16164005E-01	-0.16164005E-01	-0.16164005E-01	-0.16164005E-01
4	0.	-0.71818843E-02	-0.47271152E-02	-0.47271152E-02	-0.47271152E-02	-0.47271152E-02
5	0.	0.94077005E-02	0.7097743E-02	0.7097743E-02	0.7097743E-02	0.7097743E-02
6	0.	0.25997285E-01	0.18146664E-01	0.18146664E-01	0.18146664E-01	0.18146664E-01
7	0.	0.42586870E-01	0.29583553E-01	0.29583553E-01	0.29583553E-01	0.29583553E-01
8	0.	0.41508579E-01	0.41508579E-01	0.41508579E-01	0.41508579E-01	0.41508579E-01
9	0.40361053E-01	0.42586870E-01	0.13275082E-02	0.13275082E-02	0.13275082E-02	0.13275082E-02
10	0.27600894E-01	0.29583553E-01	0.5275082E-02	0.5275082E-02	0.5275082E-02	0.5275082E-02
11	0.21321325E-01	0.21957515E-01	0.14218732E-01	0.14218732E-01	0.14218732E-01	0.14218732E-01
12	0.20170246E-01	0.19771416E-01	0.15136584E-01	0.15136584E-01	0.15136584E-01	0.15136584E-01
13	0.13546180E-01	0.12851130E-01	0.14902129E-02	0.14902129E-02	0.14902129E-02	0.14902129E-02
14	0.11954672E-01	0.10930709E-01	0.20549057E-01	0.20549057E-01	0.20549057E-01	0.20549057E-01
15	0.75054528E-02	0.65168352E-02	0.38959118E-02	0.38959118E-02	0.38959118E-02	0.38959118E-02
16	0.62260467E-02	0.52761125E-02	0.21883357E-01	0.21883357E-01	0.21883357E-01	0.21883357E-01
17	0.31485036E-02	0.23747310E-02	0.84051325E-03	0.84051325E-03	0.84051325E-03	0.84051325E-03
18	0.29665588E-02	0.23062436E-02	0.18353146E-01	0.18353146E-01	0.18353146E-01	0.18353146E-01
19	0.10406899E-02	0.51606471E-03	0.27056164E-02	0.27056164E-02	0.27056164E-02	0.27056164E-02
20	0.11930624E-02	0.76603986E-03	0.16438887E-01	0.16438887E-01	0.16438887E-01	0.16438887E-01
21	0.15511691E-03	0.50203084E-03	0.75845311E-02	0.75845311E-02	0.75845311E-02	0.75845311E-02
22	0.40149505E-03	0.12007172E-03	0.96534154E-02	0.96534154E-02	0.96534154E-02	0.96534154E-02
23	0.26055799E-03	0.49890207E-03	0.80985198E-02	0.80985198E-02	0.80985198E-02	0.80985198E-02
24	0.25896591E-03	0.67649902E-04	0.12652164E-01	0.12652164E-01	0.12652164E-01	0.12652164E-01
25	0.48921122E-03	0.65999343E-03	0.82145771E-02	0.82145771E-02	0.82145771E-02	0.82145771E-02
26	0.25016432E-03	0.10903543E-03	0.89915197E-02	0.89915197E-02	0.89915197E-02	0.89915197E-02
27	0.19506308E-03	0.30896756E-03	0.90897661E-02	0.90897661E-02	0.90897661E-02	0.90897661E-02
28	0.26945182E-03	0.17158100E-03	0.10866134E-01	0.10866134E-01	0.10866134E-01	0.10866134E-01
29	0.17644957E-03	0.25812283E-03	0.10459142E-01	0.10459142E-01	0.10459142E-01	0.10459142E-01
30	0.32835185E-03	0.25703490E-03	0.10020779E-01	0.10020779E-01	0.10020779E-01	0.10020779E-01
31	0.14204393E-03	0.14917498E-03	0.13555770E-01	0.13555770E-01	0.13555770E-01	0.13555770E-01
32	0.28294998E-03	0.23671144E-03	0.14502764E-01	0.14502764E-01	0.14502764E-01	0.14502764E-01
33	0.27067510E-03	0.30449247E-03	0.15457764E-01	0.15457764E-01	0.15457764E-01	0.15457764E-01
34	0.27962271E-03	0.25783372E-03	0.11398896E-01	0.11398896E-01	0.11398896E-01	0.11398896E-01

28	0.14894800E-03	0.16504125E-03	0.68697336E-02	0.70222842E-02			
29	0.10018180E-03	0.93193159E-04	0.7543064E-02	0.72926510E-02			
30	0.16014977E-03	0.16472442E-03	0.13004576E-01	0.13091617E-01			
31	0.27559844E-03	0.28024760E-03	0.13552717E-01	0.13205731E-01			
32	0.16928559E-03	0.15602356E-03	0.79691389E-02	0.82710178E-02			
33	0.88522209E-04	0.10384060E-03	0.71523184E-02	0.70630977E-02			
34	0.13014971E-03	0.11408626E-03	0.11770427E-01	0.11827089E-01			
35	0.21890216E-03	0.23809486E-03	0.14064165E-01	0.13879949E-01			
36	0.18748955E-03	0.16698555E-03	0.80791265E-02	0.81836395E-02			
37	0.40711688E-04	0.66401290E-04	0.89087086E-02	0.86952867E-02			
38	0.19938609E-03	0.17217657E-03	0.12028271E-01	0.12157650E-01			
39	0.12399348E-03	0.15069636E-03	0.70462304E-02	0.70107842E-02			
40	0.58910307E-04	0.33876356E-04	0.18274589E-02	0.17912677E-02			
41	0.	0.	0.18274589E-02	0.17912677E-02			
1	0.40399990E-04	0.57674443E-01					
2	0.	-0.48089962E-01	-0.22069656E-01	-0.49129209E-01	0.53024515E-02	0.53024515E-02	-0.21930498E-01
3	0.	-0.28453041E-01	-0.12771173E-01	-0.29477523E-01	0.42672142E-02	0.42672142E-02	-0.12148555E-01
4	0.	-0.88161193E-02	-0.34726904E-02	-0.98258418E-02	0.32319769E-02	0.32319769E-02	-0.23666123E-02
5	0.	0.10820802E-01	0.58257923E-02	0.98258418E-02	0.21947396E-02	0.21947396E-02	0.74153306E-02
6	0.	0.30457724E-01	0.15124275E-01	0.29477526E-01	0.11615023E-02	0.11615023E-02	0.17197273E-01
7	0.	0.50094645E-01	0.24422758E-01	0.49129209E-01	0.12623502E-03	0.12623502E-03	0.26979216E-01
8	0.	0.49129209E-01	0.49129209E-01	0.49129209E-01			
9	0.48089962E-01	0.50094645E-01	0.53024515E-02	0.12623502E-03			
10	0.22069656E-01	0.24422758E-01	0.21930498E-01	0.26979216E-01			
11	0.23321140E-01	0.23952652E-01	0.66165836E-02	0.32441681E-02			
12	0.16747312E-01	0.15766624E-01	0.37710620E-02	0.61521930E-02			
13	0.14657444E-01	0.14141372E-01	0.17107970E-01	0.14838579E-01			
14	0.96571872E-02	0.90302357E-02	0.24732239E-02	0.43829381E-02			
15	0.88921781E-02	0.81048752E-02	0.18877296E-01	0.17164184E-01			
16	0.55463282E-02	0.48250673E-02	0.18786453E-03	0.13080444E-02			
17	0.50155978E-02	0.43275963E-02	0.18261512E-01	0.16898335E-01			
18	0.27306652E-02	0.21626032E-02	0.29815719E-02	0.41512758E-02			
19	0.28001002E-02	0.22965155E-02	0.17256560E-01	0.16297074E-01			
20	0.11411575E-02	0.73422165E-03	0.37823562E-02	0.46133753E-02			
21	0.13640009E-02	0.10129445E-02	0.14913175E-01	0.14326796E-01			
22	0.20518082E-03	0.86971341E-04	0.57320079E-02	0.62356259E-02			
23	0.57786835E-03	0.33040476E-03	0.14040392E-01	0.13593581E-01			
24	0.33268219E-03	0.54319089E-03	0.70136257E-02	0.74252889E-02			
25	0.10725136E-03	0.82157303E-04	0.83621981E-02	0.82037429E-02			
26	0.36218373E-03	0.53453056E-03	0.11552357E-01	0.11743725E-01			
27	0.26252822E-03	0.11418716E-03	0.11557673E-01	0.11249301E-01			
28	0.32267116E-03	0.45991085E-03	0.1177736E-01	0.11918124E-01			
29	0.25578634E-03	0.12736813E-03	0.92167724E-02	0.91482457E-02			
30	0.17457146E-03	0.29452580E-03	0.11330489E-01	0.11418983E-01			
31	0.3258874E-03	0.21459197E-03	0.10101342E-01	0.99793951E-02			
32	0.10643077E-03	0.21236313E-03	0.76777115E-02	0.77130831E-02			
33	0.20163257E-03	0.10799367E-03	0.65152494E-02	0.62929613E-02			
34	0.55601104E-04	0.13933073E-03	0.89616113E-02	0.91371842E-02			
35	0.28081908E-03	0.20182802E-03	0.13522413E-01	0.13433584E-01			
36	0.21337362E-03	0.28399022E-03	0.13111815E-01	0.13319929E-01			
37	0.24909991E-03	0.18217880E-03	0.80550329E-02	0.79773047E-02			
38	0.31443393E-04	0.86085951E-04	0.72521137E-02	0.75626539E-02			
39	0.20498939E-03	0.15918322E-03	0.13258946E-01	0.13003093E-01			
40	0.21396901E-03	0.25396372E-03	0.13433189E-01	0.13632176E-01			
41	0.20047046E-03	0.16597427E-03	0.91775388E-02	0.89968622E-02			
42	0.75690507E-04	0.10319805E-03	0.66520820E-02	0.68674410E-02			
43	0.11664459E-03	0.95857474E-04	0.12444569E-01	0.12219263E-01			
44	0.23248236E-03	0.24604241E-03	0.10938869E-01	0.11256133E-01			
45	0.69802003E-04	0.64482289E-04	0.56983604E-02	0.53966678E-02			
46	0.80143586E-04	0.81082341E-04	0.43597969E-02	0.45322810E-02			
47	0.34560176E-04	0.36348315E-04	0.14372541E-02	0.13281776E-02			
48	0.	0.	0.14372541E-02	0.13281776E-02			

END-OF-DATA ENCOUNTERED ON SYSTEM INPUT FILE.

