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**COMPUTER PROGRAMS IN OCEAN ENGINEERING**

Prepared by

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Texas A&M University

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COMPUTER PROGRAMS

IN

OCEAN ENGINEERING

by

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## ABSTRACT

In response to a need for repeated and sometime cumbersome computations in ocean engineering several, most used, computer programs were assembled in this report. The computer programs were developed, or adapted for the IBM 360-65 computer available on the College Station Campus of Texas A&M University.

The computer programs are for:

- (1) Stokes' Third Order Wave Theory
- (2) Cnoidal Wave Theory
- (3) Wave Forces and Moments on Circular Cylindrical Piles by  
Small Amplitude Wave Theory.
- (4) Combined Effect of Refraction and Diffraction of Water Waves
- (5) Dynamic Response of Offshore Piling

## PREFACE

Development of computer programs was conducted as part of general research program in Coastal and Ocean Engineering at Texas A&M University.

Various portions of the report were prepared by different authors and assembled by Cecil M. McClenan under supervision of Dr. John B. Herbich.

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## I. INTRODUCTION

Computer programs are a very useful aid in determining wave characteristics in coastal and ocean engineering. These programs were developed or adapted from various sources in connection with several projects in the Coastal and Ocean Engineering Division at Texas A&M University.

The programs are for:

- (1) Stokes' Third Order Theory
- (2) Cnoidal Wave Theory
- (3) Wave Forces and Moments on Circular Cylindrical Piles by  
Small Amplitude Wave Theory
- (4) Combined Effect of Refraction and Diffraction of Water Waves
- (5) Dynamic Response of Offshore Piling

## II. STOKES' THIRD ORDER WAVE THEORY

### 1. General Comment

This program calculates values describing water particle motion using Stokes' third order wave theory. This wave theory is most nearly valid in water with a relative depth,  $d/L$  greater than  $1/8$ .

Water particle velocities and accelerations in the horizontal and vertical directions are calculated at different intervals of depth and position along a wave.

The wavelength is dependent upon the wave height, wave period, and water depth. Before the velocities and accelerations can be calculated, the wavelength must be found. This is done by an iterative process knowing the dependent variables listed above. This program calculates the exact wavelength.

### 2. Program Description

#### *Main Program*

**Purpose:** To calculate water particle velocities and accelerations given wave height, wave period, and water depth.

**Equations:** In solving for the wavelength, the following equation is used:

$$H = 2a + 2 \frac{\pi^2}{L^2} a^3 \cdot f_3\left(\frac{d}{L}\right)$$

where

$$f_3\left(\frac{d}{L}\right) = \frac{3}{16} \frac{1 + 8 \cosh^6(2\pi d/L)}{\sinh^6(2\pi d/L)}$$

The above equation equates to:

$$a^3 + \frac{L^2}{\pi^2 f_3\left(\frac{L}{d}\right)} a - \frac{HL^2}{2\pi^2 f_3\left(\frac{L}{d}\right)} = 0$$

The only real solution of 'a' is:

$$a = A + B$$

where

$$A = (-.5b_1 + \sqrt{.25b_1^2 + a_1^3/27})^{1/3}$$

$$B = (-.5b_1 - \sqrt{.25b_1^2 + a_1^3/27})^{1/3}$$

where

$$a_1 = L^2 / (\pi^2 f_3 (d/L))$$

$$b_1 = -HL^2 / (2\pi^2 f_3 (d/L))$$

The program initially begins with the depth water wavelength given by

$$L = 5.12 T^2$$

and rapidly approaches the exact wavelength.

A series of iterations for a particular problem is shown below. It can be seen how the trial wavelengths close on the exact value.

Trial Wavelength	Calculated Wavelength
0.68140110E 03	0.67308470E 03
0.67724290E 03	0.67464790E 03
0.67594530E 03	0.67513590E 03
0.67554050E 03	0.67528750E 03
0.67541400E 03	0.67533540E 03
0.67537470E 03	0.67535030E 03
0.67536250E 03	0.67534420E 03
0.67535880E 03	0.67535640E 03
0.67535760E 03	0.67535660E 03
0.67545710E 03	0.67535660E 03
0.67535690E 03	0.67535690E 03

$$L_{\text{exact}} = 675.3569 \text{ ft.}$$

For values of wave height, water depth, and wave period given below.

$$H = 35.0 \text{ ft.}$$

$$d = 15.0 \text{ ft.}$$

$$T = 12.0 \text{ sec.}$$



The equation used to find the calculated wavelength is:

$$L = \frac{gT^2}{2\pi} \tanh\left(\frac{2\pi d}{L}\right) \left[ 1 + \left(\frac{2\pi a}{L}\right)^2 \frac{14 + 4 \cosh^2(4\pi d/L)}{16 \sinh^4(2\pi d/L)} \right]$$

After solution of L, the wave speed can now be calculated

$$C = L/T$$

The wave crest

$$Y_c = A_1 + A_2 + A_3$$

where

$$A_1 = a/L$$

$$A_2 = \pi A_1^2 f_2\left(\frac{d}{L}\right)$$

$$A_3 = \pi^2 A_1^3 f_3\left(\frac{d}{L}\right)$$

$$f_2\left(\frac{d}{L}\right) = \frac{2 + \cosh(4\pi d/L) \cosh(2\pi d/L)}{2 \sinh^3(2\pi d/L)}$$

The wave trough

$$Y_t = Y_c - H$$

The water surface profile

$$Y_s = L[A_1 \cos(G) + A_2 \cos(2G) + A_3 \cos(3G)]$$

$$G = 2\pi\left(\frac{x}{L} - \frac{t}{T}\right)$$

The water particle velocities

Horizontal:

$$u = CF_1 \cosh(K) \cos(G) + CF_2 \cosh(2K) \cos(2G) + CF_3 \cosh(3K) \cos(3G)$$

Vertical:

$$v = CF_1 \sinh(K) \sin(G) + CF_2 \sinh(2K) \sin(2G) + CF_3 \sinh(3K) \sin(3G)$$

where

$$K = \frac{2\pi}{L} (y + d)$$

$$F_1 = \frac{2\pi a}{L} \cdot \frac{1}{\sinh(2\pi d/L)}$$

$$F_2 = \frac{3}{4} \left( \frac{2\pi a}{L} \right)^2 \cdot \frac{1}{\sinh^4(2\pi d/L)}$$

$$F_3 = \frac{3}{64} \left( \frac{2\pi a}{L} \right)^3 \cdot \frac{11 - 2\cosh(4\pi d/L)}{\sinh^7(2\pi d/L)}$$

The water particle local accelerations:

Horizontal:

$$\begin{aligned} a_x &= \frac{2\pi C}{T} F_1 \cosh(K) \sin(G) \\ &+ \frac{4\pi C}{T} F_2 \cosh(2K) \sin(2G) \\ &+ \frac{6\pi C}{T} F_3 \cosh(3K) \sin(3G) \end{aligned}$$

$$\begin{aligned} a_y &= - \frac{2\pi C}{T} F_1 \sinh(K) \cos(G) \\ &- \frac{4\pi C}{T} F_2 \sinh(2K) \cos(2G) \\ &- \frac{6\pi C}{T} F_3 \sinh(3K) \cos(3G) \end{aligned}$$

## 3. Notation

Symbol	FORTTRAN Name	Description
H	H	wave height
a	A	useful function
L	WL	wavelength
d	D	water depth
T	T	wave period
C	CEL	wave speed
u	U	water particle velocity in the horizontal direction
v	V	water particle velocity in the vertical direction
$a_x$	AX	water particle local accel- eration in the horizontal direction
$a_y$	AY	water particle local accel- eration in the vertical direction

## 4. Bibliography

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C STOKES THIRD ORDER WAVE THEORY  
 C  
 C FOR WAVE CONDITIONS WHERE D/L GREATER THAN 1/10  
 C  
 C T=WAVE PERIOD  
 C H=WAVE HEIGHT  
 C D=WATER DEPTH  
 C DEPNIC=DEPTH INCREMENTATION DESIRED (SHOULD BE AN INTEGER)  
 C SYMBOL AND NPRINT = 0(ZERO) (THESE ARE NEEDED IN SUBROUTINE GRAPH)  
 C XHEAD, YHEAD, AND TITLE ARE THE HEADINGS OF THE X-AXIS, Y-AXIS, AND  
 C TITLE OF EACH GRAPH  
 C WL=WAVELENGTH  
 C CEL=WAVE SPEED  
 C YC=HEIGHT OF WAVE CREST  
 C YT=DEPTH OF WAVE TROUGH  
 C XDL=DISTANCE ALONG WAVE IN LENGTH  
 C TDT=DISTANCE ALONG WAVE IN TIME  
 C Y=DISTANCE TO A WATER PARTICLE FROM THE BOTTOM  
 C U=HORIZONTAL VELOCITY OF A PARTICLE AT DISTANCE Y FROM THE BOTTOM  
 C V=VERTICAL VELOCITY OF A PARTICLE AT DISTANCE Y FROM THE BOTTOM  
 C AX=HORIZONTAL ACCELERATION OF A PARTICLE AT DISTANCE Y FROM THE  
 C BOTTOM  
 C AZ=VERTICAL ACCELERATION OF A PARTICLE AT DISTANCE Y FROM THE  
 C BOTTOM  
 C

1 DIMENSION UP(999),VP(999),AXP(999),AZP(999),YSP(50),XHEAD(5),YHEAD  
 1(5),TITLE(10),XHFADA(5),XHEADB(5),XHFADC(5),XHFADD(5),YHEADA(5),YH  
 2EADB(5),YHEADC(5),YHEADD(5),TITLEA(10),TITLEB(10),TITLEC(10),TITL  
 3E(10),YP(999),XDLP(50),NAME(20,20)  
 4 READ(5,101)(XHFAD(I),I=1,5)  
 5 READ(5,101)(XHFADA(I),I=1,5)  
 6 READ(5,101)(XHEADB(I),I=1,5)  
 7 READ(5,101)(XHFADC(I),I=1,5)  
 8 READ(5,101)(XHFADD(I),I=1,5)  
 9 READ(5,101)(YHEAD(I),I=1,5)  
 10 READ(5,101)(YHEADA(I),I=1,5)  
 11 READ(5,101)(YHEADB(I),I=1,5)  
 12 READ(5,101)(YHEADC(I),I=1,5)  
 13 READ(5,101)(YHFADD(I),I=1,5)  
 14 READ(5,101)(TITLE(I),I=1,10)  
 15 READ(5,101)(TITLEA(I),I=1,10)  
 16 READ(5,101)(TITLEB(I),I=1,10)  
 17 READ(5,101)(TITLEC(I),I=1,10)  
 18 READ(5,101)(TITLED(I),I=1,10)  
 19 READ(5,100)T,H,D,DEPNIC,SYMBOL,NPRINT

C  
 C DEFINE CONSTANTS  
 C  
 18 L=0  
 19 G=32.2  
 20 PI=3.141593  
 C  
 C SFT INITIAL VALUE OF WAVELENGTH EQUAL TO DEEP WATER WAVELENGTH  
 C  
 21 WL =5.12\*T\*T  
 C  
 C BEGIN ITERATIVE PROCESS TO SOLVE FOR ACTUAL WAVELENGTH  
 C  
 22 10 X=2.\*PI\*D/WL

```

23      CF31=COSH(X)*COSH(X)*COSH(X)*COSH(X)*COSH(X)*COSH(X)
24      CF32=SINH(X)*SINH(X)*SINH(X)*SINH(X)*SINH(X)*SINH(X)
25      F3=(3./16.)*(1.+(8.*CF31))/CF32
26      A1=WL*WL/(PI*PI*F3)
27      B1=-H*WL*WL/(2.*PI*PI*F3)
28      A=(-.5*B1+SQRT(.25*B1*B1+A1*A1*A1/27.))**(1./3.)
29      B=(-.5*B1-SQRT(.25*B1*B1+A1*A1*A1/27.))
30      BB=B
31      B=ABS(B)**(1./3.)
32      SIGN = 1.
33      IF(BB.LT.0.) SIGN = -1.
34      A=A+SIGN*B
35      C1=14.+4.*COSH(2.*X)*COSH(2.*X)
36      C2=16.*SINH(X)*SINH(X)*SINH(X)*SINH(X)
37      C=1.+(2.*PI*A/WL)**2.)*C1/C2
38      WLT=(.5*G*T/T/PI)*(TANH(X))*C
39      WRITE(6,111)WL,WLT
40      111 FORMAT(2E16.8)
41      DIFF=WL-WLT
42      WL=(WL+WLT)/2.
43      IF(ABS(DIFF).GT.0.01) GO TO 10

C
C
C      FND OF ITERATIVE PROCESS TO SOLVE FOR ACTAL VALUE CF WAVELENGTH

44      CF2=(2.+COSH(2.*X))*COSH(X)
45      CF21=2.*SINH(X)*SINH(X)*SINH(X)
46      F2=CF2/CF21
47      CFL=WL/T
48      A1=A/WL
49      A2=PI*A1*A1*F2
50      A3=PI*PI*A1*A1*A1*F3
51      F1=2.*PI*A/(WL*SINH(X))
52      F2=3.*PI*PI*A*A/(WL*WL*SINH(X)*SINH(X)*SINH(X)*SINH(X))
53      F3=((3./16.)*PI*PI*A*A/(WL*WL))*(1.-2.*COSH(2.*X))/(SINH(X)**7.)
54      1)*2.*PI*A/WL
55      YC=(A1+A2+A3)*WL
56      YT=YC-H
57      WRITE(6,200) WL,H,D,YC,YT,CEL,T,A1,A2,A3,F1,F2,F3,A
58      XDL=0.0
59      TDT=0.0
      C=2.*PI*CEL/T

C
C
C      BEGIN DO LOOP TO CALCULATE VEL AND ACCEL AT DIFFERENT PLACES ALONG
      THE WAVE

60      DO 70 KK=1,11
61      WRITE(6,300)XDL
62      TH=2.*PI*(XDL-TDT)
63      COSTH=COS(TH)
64      COS2TH=COS(TH*2.)
65      COS3TH=COS(TH*3.)
66      SINTH=SIN(TH)
67      SIN2TH=SIN(2.*TH)
68      SIN3TH=SIN(3.*TH)
69      YS=WL*(A1*COSTH+A2*COS2TH+A3*COS3TH)
70      I =(YS+D)/DEP INC+2
71      KY=YS+2.*DEP INC
72      KY=KY/DEP INC
73      KY=KY*DEP INC
74      Y=KY

```

```

C      BEGIN DO LOOP TO CALCULATE VEL AND ACCEL ALONG VERTICAL PROFILES
C
75     DO 40 N=1,I
76     Y=KY-DEPINC*N
77     IF(N.EQ.1)Y=YS
78     IF(Y.GT.YS)KY=KY-DEPINC
79     IF(Y.GT.YS)Y=Y-DEPINC
80     XY=2.*PI*(Y+D)/WL
81     COSHX=COSH(XY)
82     COSH2X=COSH(2.*XY)
83     COSH3X=COSH(3.*XY)
84     SINHX=SINH(XY)
85     SINH2X=SINH(2.*XY)
86     SINH3X=SINH(3.*XY)
87     U=(F1*COSHX*COSTH+F2*COSH2X *COS2TH+F3*COSH3X *COS3TH)*CFL
88     V=(SINHX*F1*SINTH+F2*SINH2X *SIN2TH+F3*SINH3X *SIN3TH)*CEL
89     AX=C*(F1*COSHX*SINTH+2.*F2*COSH2X *SIN2TH+3.*F3*COSH3X *SIN3TH)
90     AZ=-C*(F1*SINHX*COSTH+2.*F2*SINH2X *COS2TH+3.*F3*SINH3X *COS3TH)
91     L=L+1
92     UP(L)=U
93     VP(L)=V
94     AXP(L)=AX
95     AZP(L)=AZ
96     YP(L)=Y
97     40 WRITE(6,400)Y,U,V,AX,AZ
98     YSP(KK)=YS
99     XDLP(KK)=XDL
100    70 XDL=XDL+0.05
101    NM=1
102    CALL GRAPH(UP,YP,L,SYMBOL,XHEAD,YHEAD,TITLE,NPRINT)
103    CALL GRAPH(VP,YP,L,SYMBOL,XHEAD,YHEAD,TITLEA,NPRINT)
104    CALL GRAPH(AXP,YP,L,SYMBOL,XHEADB,YHEADB,TITLEB,NPRINT)
105    CALL GRAPH(AZP,YP,L,SYMBOL,XHEADC,YHEADC,TITLEC,NPRINT)
106    CALL GRAPH(XDLP,YSP,NM,SYMBOL,XHEADD,YHEADD,TITLED,NPRINT)
107    100 FORMAT(5F10.4,8I1)
108    101 FORMAT(10A4)
109    200 FORMAT(1H1,/////,T45,'          STOKES THIRD ORDER WAVE THEORY          ',
110    ' 1  // // //,T50,' WAVE LENGTH          =',F10.3,///,T50,' WAVE HEIGHT          =',
111    ' 2F10.3,///,T50,' WATER DEPTH          =',F10.3,///,T50,' YC          =',
112    ' 3F10.3,///,T50,' YT          =',F10.3,///,T50,' WAVE CELERITY          =',
113    ' 4F10.3,///,T50,' WAVE PERIOD          =',F10.3,///,T50,' A1          =',
114    ' 5F14.7,///,T50,' A2          =',F14.7,///,T50,' A3          =',
115    ' 6E14.7,///,T50,' F1          =',F14.7,///,T50,' F2          =',
116    ' 7E14.7,///,T50,' F3          =',E14.7,///,T50,' A          =',
117    ' 8F14.7)
118    300 FORMAT(1H),T60,' X/L =',F4.2,3(//),T36,' Y',T44,' HORIZONTAL',T60,' VER
119    TICAL',T76,' HORIZONTAL',T93,' VERTICAL',/,T45,' VELOCITY',T60,' VELOC
120    2ITY',T75,' ACCELERATION',T91,' ACCELERATION',/)
121    400 FORMAT(T26,F13.2,4F16.6)
122    STOP
123    END
124
125    SUBROUTINE GRAPH(DATAX,DATAY,I,SYMBOL,XHEAD,YHEAD,TITLE,NPRINT)
126    DIMENSION DATAX(I),DATAY(I)
127    DIMENSION PLOT(122,52),YSCALE(6),XSCALE(7),XHEAD(5),YHEAD(5)
128    DIMENSION TITLE(10)
129    DATA AST,BLANK,YAXIS,XAXIS,PCINT,A,B,C,D,F/'*',' ','I','-',
130    ' ','A','B','C','D','E'/
131    SAVSYM=SYMBOL
132    IF(SYMBOL.EQ.0.0) SYMBOL=AST
133    IF(NPRINT.EQ.2.OR.NPRINT.EQ.3) GO TO 190

```

```

122     XMAX=DATA(X)
123     XMIN=XMAX
124     DO 180 K=2,I
125     IF(DATA(X) .GT.XMAX) XMAX=DATA(X)
126     IF(DATA(X) .LT.XMIN) XMIN=DATA(X)
127     180 CONTINUE
128     190 CONTINUE
129     YMAX=DATA(Y)
130     YMIN=YMAX
131     DO 10 K=2,I
132     IF(DATA(Y) .GT.YMAX) YMAX=DATA(Y)
133     IF(DATA(Y) .LT.YMIN) YMIN=DATA(Y)
134     10 CONTINUE
135     IF(XMAX.LE.XMIN.OR.YMAX.LE.YMIN) GO TO 9998
136     IF(NPRINT.EQ.2.OR.NPRINT.EQ.3) GO TO 200
137     CALL SIGNIF(XMIN,2,SCALE,SIGX,N)
138     IF(SIGX.LT.0.0) NSIGX=SIGX-9.5
139     IF(SIGX.GE.0.0) NSIGX=SIGX+9.5
140     SIGX=NSIGX/10*10
141     XBOT=SIGX*(SCALE**(N+1)/SCALE)
142     XRANGE=XMAX-XBOT
143     CALL SIGNIF(XRANGE,2,SCALE,SIGX,N)
144     NSIG=(SIGX+5.500)/6.0
145     XRANGE=NSIG*6
146     XRANGE=XRANGE*(SCALE**(N+1)/SCALE)
147     XTOP=XBOT+XRANGE
148     CALL SIGNIF(YMIN,2,SCALE,SIGY,N)
149     IF(SIGY.LT.0.0) NSIGY=SIGY-9.5
150     IF(SIGY.GE.0.0) NSIGY=SIGY+9.5
151     SIGY=NSIGY/10*10
152     YBOT=SIGY*(SCALE**(N+1)/SCALE)
153     YRANGE=YMAX-YBOT
154     CALL SIGNIF(YRANGE,2,SCALE,SIGY,N)
155     NSIG=(SIGY+4.500)/5.0
156     YRANGE=NSIG*5
157     YRANGE=YRANGE*(SCALE**(N+1)/SCALE)
158     YTOP=YBOT+YRANGE
159     200 CONTINUE
160     IF(NPRINT.EQ.2.OR.NPRINT.EQ.3) GO TO 160
161     DO 30 M=2,122
162     DO 30 K=1,51
163     PLOT(M,K)=BLANK
164     30 CONTINUE
165     20 CONTINUE
166     DO 40 M=1,51
167     PLOT(1,M)=YAXIS
168     40 CONTINUE
169     DO 50 M=1,122
170     PLOT(M,52)=XAXIS
171     50 CONTINUE
172     DO 100 L=2,122,20
173     PLOT(L,52)=YAXIS
174     100 CONTINUE
175     DO 110 L=1,51,10
176     PLOT(1,L)=XAXIS
177     110 CONTINUE
178     XSCALE(1)=XBOT
179     XSCALE(7)=XTOP
180     DO 120 L=2,6
181     X=L-1
182     XSCALE(L)=XBOT+X*XRANGE/6.0

```



```

183 120 CONTINUE
184   YSCALE(6)=YBOT
185   DO 130 L=1,5
186     X=6-L
187     YSCALE(L)=YBOT+X*YRANGE/5.0
188 130 CONTINUE
189 160 CONTINUE
190   DO 60 J=1,I
191     SYM=SYMBOL
192     X1=DATA(X(J))-XBOT
193     X2=X1/XRANGE
194     JX=X2*120.0+2.5
195     IF(JX.LT.2) GO TO 900
196     IF(JX.GT.122) GO TO 901
197   70 Y1=DATA(Y(J))-YBOT
198     Y2=Y1/YRANGE
199     JY=51.5-(Y2*50.0)
200     IF(JY.LT.1) GO TO 903
201     IF(JY.GT.51) GO TO 902
202   80 PLOT(JX,JY)=SYM
203     GO TO 60
204 900 JX=2
205     SYM=POINT
206     GO TO 70
207 901 JX=122
208     SYM=POINT
209     GO TO 70
210 902 JY=51
211     SYM=POINT
212     GO TO 80
213 903 JY=1
214     SYM=POINT
215     GO TO 80
216 60 CONTINUE
217   IF(NPRINT.EQ.1.OR.NPRINT.EQ.2) GO TO 170
218   WRITE(6,501)
219 501 FORMAT(1H1)
220   LINE=1
221   DO 140 M=1,5
222     LSTOP=LINE+9
223     WRITE(6,500) (PLOT(K,LINE),K=1,122),YSCALE(M)
224 500 FORMAT('1X,12?A1,T2,F10.5)
225     LINE=LINE+1
226     DO 150 J=LINE,LSTOP
227       WRITE(6,500) (PLOT(K,J),K=1,122)
228 150 CONTINUE
229     LINE=LINE+9
230 140 CONTINUE
231     WRITE(6,500) (PLOT(K,51),K=1,122),YSCALE(6)
232     WRITE(6,500) (PLOT(K,52),K=1,122)
233     WRITE(6,504) (XSCALE(K),K=1,7)
234 504 FORMAT(8X,6(F10.5),10X),T124,F10.5)
235     WRITE(6,505) XHEAD,YHEAD
236 505 FORMAT(/,40X,'HORIZONTAL AXIS - ',5A4,/,
237   1 4?X,'VERTICAL AXIS - ',5A4)
237     WRITE(6,506) TITLE
238 506 FORMAT(/,T48,5A4,/,T48,5A4,/,1H1)
239 170 CONTINUE
240     SYMBOL=SAVSYM
241     RETURN
242 9998 CONTINUE

```

```

243 WRITE(6,502)
244 502 FORMAT(1H1,10X,'MAX X OR Y VALUE EQUALS MIN VALUE',//////)
245 SYMBOL=SAVSYM
246 RETURN
247 END

```

```

248 SUBROUTINE SIGNIF(VALUE,NUMB,SCALE,SIG,N)
249 HIGH=10.0**NUMB
250 SCALE=0.1**NUMB
251 BSCALE=10.0
252 IF (ABS(VALUE).GE.1.0) GO TO 30
253 SCALE=10.0**NUMB
254 BSCALE=0.1
255 30 M=0
256 IF (ABS(VALUE).GE.1.0.AND.ABS(VALUE).LT.HIGH) GO TO 20
257 GO TO M=1,25
258 VALUE=VALUE*SCALE
259 IF (ABS(VALUE).GE.1.0.AND.ABS(VALUE).LT.HIGH) GO TO 20
260 10 CONTINUE
261 20 N=M*NUMB
262 NVALUE=VALUE
263 SCALE=BSCALE
264 IF (NUMB.LT.2) GO TO 40
265 IF (ABS(VALUE).GE.10.0) GO TO 40
266 NVALUE=10.0*VALUE
267 IF (SCALE.LT.1.0) N=N+1
268 IF (SCALE.GE.1.0) N=N-1
269 40 SIG=NVALUE
270 RETURN
271 END

```

//SDATA

```

0.73727970E 03 0.65216080E 03
0.69472020E 03 0.66808260E 03
0.68140110E 03 0.67309470E 03
0.67724290E 03 0.67464790E 03
0.67594530E 03 0.67513590E 03
0.67554050E 03 0.67528750E 03
0.67541400E 03 0.67533540E 03
0.67537470E 03 0.67535030E 03
0.67536250E 03 0.67535520E 03

```

STOKES THIRD ORDER WAVE THEORY

WAVE LENGTH = 675.350

WAVE HEIGHT = 35.000

WATER DEPTH = 150.000

YC = 19.695

YT = -15.305

WAVE CELERITY = 56.280

WAVE PERIOD = 12.000

A1 = 0.2540417E-01

A2 = 0.3250521E-02

A3 = 0.5079710E-03

F1 = 0.8424634E-01

F2 = 0.1482848E-02

F3 = -0.1165606E-04

A = 0.1715694E 02

X/L =0.00

Y	HORIZONTAL VELOCITY	VERTICAL VELOCITY	HORIZONTAL ACCELERATION	VERTICAL ACCELERATION
19.70	0.129296E 02	0.000000E 00	0.000000E 00	-0.672971E C1
18.00	0.127289E 02	0.000000E 00	0.000000E 00	-0.660221E C1
16.00	0.124969E 02	0.000000E 00	0.000000E 00	-0.645471E C1
14.00	0.122700E 02	0.000000E 00	0.000000E 00	-0.631029E C1
12.00	0.120483E 02	0.000000E 00	0.000000E 00	-0.616888E C1
10.00	0.118316E 02	0.000000E 00	0.000000E 00	-0.603039E C1
8.00	0.116197E 02	0.000000E 00	0.000000E 00	-0.589475E C1
6.00	0.114126E 02	0.000000E 00	0.000000E 00	-0.576189E C1
4.00	0.112102E 02	0.000000E 00	0.000000E 00	-0.563174E C1
2.00	0.110123E 02	0.000000E 00	0.000000E 00	-0.550424E C1
-0.00	0.108189E 02	0.000000E 00	0.000000E 00	-0.537930E C1
-2.00	0.106299E 02	0.000000E 00	0.000000E 00	-0.525687E C1
-4.00	0.104453E 02	0.000000E 00	0.000000E 00	-0.513687E C1
-6.00	0.102648E 02	0.000000E 00	0.000000E 00	-0.501926E C1
-8.00	0.100885E 02	0.000000E 00	0.000000E 00	-0.490397E C1
-10.00	0.991624E 01	0.000000E 00	0.000000E 00	-0.479093E C1
-12.00	0.974796E 01	0.000000E 00	0.000000E 00	-0.468009E C1
-14.00	0.958359E 01	0.000000E 00	0.000000E 00	-0.457139E C1
-16.00	0.942303E 01	0.000000E 00	0.000000E 00	-0.446478E C1
-18.00	0.926623E 01	0.000000E 00	0.000000E 00	-0.436020E C1
-20.00	0.911312E 01	0.000000E 00	0.000000E 00	-0.425760E C1
-22.00	0.896361E 01	0.000000E 00	0.000000E 00	-0.415692E C1
-24.00	0.881765E 01	0.000000E 00	0.000000E 00	-0.405812E C1
-26.00	0.867517E 01	0.000000E 00	0.000000E 00	-0.396114E C1
-28.00	0.853609E 01	0.000000E 00	0.000000E 00	-0.386594E C1
-30.00	0.840038E 01	0.000000E 00	0.000000E 00	-0.377248E C1
-32.00	0.826796E 01	0.000000E 00	0.000000E 00	-0.368070E C1
-34.00	0.813876E 01	0.000000E 00	0.000000E 00	-0.359055E C1
-36.00	0.801274E 01	0.000000E 00	0.000000E 00	-0.350200E C1
-38.00	0.788985E 01	0.000000E 00	0.000000E 00	-0.341501E C1
-40.00	0.777001E 01	0.000000E 00	0.000000E 00	-0.332952E C1
-42.00	0.765319E 01	0.000000E 00	0.000000E 00	-0.324550E C1
-44.00	0.753932E 01	0.000000E 00	0.000000E 00	-0.316290E C1
-46.00	0.742837E 01	0.000000E 00	0.000000E 00	-0.308170E C1
-48.00	0.732028E 01	0.000000E 00	0.000000E 00	-0.300184E C1
-50.00	0.721507E 01	0.000000E 00	0.000000E 00	-0.292329E C1
-52.00	0.711250E 01	0.000000E 00	0.000000E 00	-0.284602E C1
-54.00	0.701272E 01	0.000000E 00	0.000000E 00	-0.276998E C1
-56.00	0.691561E 01	0.000000E 00	0.000000E 00	-0.269515E C1
-58.00	0.682115E 01	0.000000E 00	0.000000E 00	-0.262148E C1
-60.00	0.672928E 01	0.000000E 00	0.000000E 00	-0.254894E C1
-62.00	0.663997E 01	0.000000E 00	0.000000E 00	-0.247751E C1
-64.00	0.655318E 01	0.000000E 00	0.000000E 00	-0.240714E C1
-66.00	0.646888E 01	0.000000E 00	0.000000E 00	-0.233780E C1
-68.00	0.638702E 01	0.000000E 00	0.000000E 00	-0.226946E C1
-70.00	0.630757E 01	0.000000E 00	0.000000E 00	-0.220210E C1
-72.00	0.623049E 01	0.000000E 00	0.000000E 00	-0.213567E C1
-74.00	0.615576E 01	0.000000E 00	0.000000E 00	-0.207016E C1
-76.00	0.608335E 01	0.000000E 00	0.000000E 00	-0.200552E C1
-78.00	0.601322E 01	0.000000E 00	0.000000E 00	-0.194174E C1
-80.00	0.594533E 01	0.000000E 00	0.000000E 00	-0.187879E C1
-82.00	0.587968E 01	0.000000E 00	0.000000E 00	-0.181662E C1
-84.00	0.581621E 01	0.000000E 00	0.000000E 00	-0.175523E C1
-86.00	0.575492E 01	0.000000E 00	0.000000E 00	-0.169457E C1
-88.00	0.569576E 01	0.000000E 00	0.000000E 00	-0.163463E C1

-90.00	0.563873E 01	0.000000E 00	0.000000E 00	-0.157538F C1
-92.00	0.558379E 01	0.000000E 00	0.000000E 00	-0.151678E C1
-94.00	0.553097E 01	0.000000E 00	0.000000E 00	-0.145883E C1
-96.00	0.548010E 01	0.000000E 00	0.000000E 00	-0.140148F C1
-98.00	0.543130F 01	0.000000E 00	0.000000E 00	-0.134473E C1
-100.00	0.538452E 01	0.000000E 00	0.000000E 00	-0.128853E C1
-102.00	0.533972E 01	0.000000E 00	0.000000E 00	-0.123287E C1
-104.00	0.529688E 01	0.000000E 00	0.000000E 00	-0.117773E C1
-106.00	0.525601E 01	0.000000E 00	0.000000E 00	-0.112308F 01
-108.00	0.521706F 01	0.000000E 00	0.000000E 00	-0.106889E C1
-110.00	0.518003E 01	0.000000E 00	0.000000E 00	-0.101515E C1
-112.00	0.514491F 01	0.000000E 00	0.000000E 00	-0.961830E 00
-114.00	0.511167E 01	0.000000E 00	0.000000E 00	-0.908909E 00
-116.00	0.508030E 01	0.000000E 00	0.000000E 00	-0.856365E 00
-118.00	0.505080F 01	0.000000E 00	0.000000E 00	-0.804175E 00
-120.00	0.502314E 01	0.000000E 00	0.000000E 00	-0.752319E 00
-122.00	0.499732F 01	0.000000E 00	0.000000E 00	-0.700773E 00
-124.00	0.497333F 01	0.000000E 00	0.000000E 00	-0.649517E 00
-126.00	0.495116F 01	0.000000E 00	0.000000E 00	-0.598530E 00
-128.00	0.493079E 01	0.000000E 00	0.000000E 00	-0.547789F 00
-130.00	0.491222E 01	0.000000E 00	0.000000E 00	-0.497275E 00
-132.00	0.489545E 01	0.000000E 00	0.000000E 00	-0.446965E 00
-134.00	0.488045E 01	0.000000E 00	0.000000E 00	-0.396840E 00
-136.00	0.486724F 01	0.000000E 00	0.000000E 00	-0.346878E 00
-138.00	0.485580F 01	0.000000E 00	0.000000E 00	-0.297060E 00
-140.00	0.484612F 01	0.000000E 00	0.000000E 00	-0.247363E 00
-142.00	0.483821E 01	0.000000E 00	0.000000E 00	-0.197768E 00
-144.00	0.483207E 01	0.000000E 00	0.000000E 00	-0.148255E 00
-146.00	0.482768E 01	0.000000E 00	0.000000E 00	-0.988029E-01
-148.00	0.482504E 01	0.000000E 00	0.000000E 00	-0.493913E-01
-150.00	0.482417E 01	0.000000E 00	0.000000E 00	-0.000000E 00

X/L = 0.05

Y	HORIZONTAL VELOCITY	VERTICAL VELOCITY	HORIZONTAL ACCELERATION	VERTICAL ACCELERATION
18.29	0.120158E 02	0.388486E 01	0.245978E 01	-0.617862E 01
18.00	0.119835E 02	0.387199E 01	0.245214E 01	-0.615830E 01
16.00	0.117571E 02	0.378577E 01	0.240102E 01	-0.602209E 01
14.00	0.115555E 02	0.370133E 01	0.235120E 01	-0.588867E 01
12.00	0.113486E 02	0.361864E 01	0.230266E 01	-0.575800E 01
10.00	0.111462E 02	0.353766E 01	0.225535E 01	-0.562999E 01
8.00	0.109484E 02	0.345834E 01	0.220924E 01	-0.550457E 01
6.00	0.107550E 02	0.338063E 01	0.216431E 01	-0.538168E 01
4.00	0.105659E 02	0.330449E 01	0.212053E 01	-0.526125E 01
2.00	0.103810E 02	0.322990E 01	0.207787E 01	-0.514323E 01
-0.00	0.102003E 02	0.315680E 01	0.203630E 01	-0.502755E 01
-2.00	0.100236E 02	0.308516E 01	0.199579E 01	-0.491415E 01
-4.00	0.985099E 01	0.301494E 01	0.195632E 01	-0.480298E 01
-6.00	0.968224E 01	0.294611E 01	0.191787E 01	-0.469397E 01
-8.00	0.951735E 01	0.287862E 01	0.188041E 01	-0.458708E 01
-10.00	0.935620E 01	0.281245E 01	0.184392E 01	-0.448223E 01
-12.00	0.919875E 01	0.274756E 01	0.180837E 01	-0.437940E 01
-14.00	0.904492E 01	0.268391E 01	0.177374E 01	-0.427851E 01
-16.00	0.889464E 01	0.262148E 01	0.174001E 01	-0.417953E 01
-18.00	0.874784E 01	0.256023E 01	0.170716E 01	-0.408241E 01
-20.00	0.860447E 01	0.250014E 01	0.167517E 01	-0.398709E 01
-22.00	0.846445E 01	0.244116E 01	0.164402E 01	-0.389352E 01
-24.00	0.832773E 01	0.238328E 01	0.161369E 01	-0.380167E 01
-26.00	0.819423E 01	0.232646E 01	0.158415E 01	-0.371148E 01
-28.00	0.806391E 01	0.227068E 01	0.155540E 01	-0.362292E 01
-30.00	0.793672E 01	0.221591E 01	0.152742E 01	-0.353595E 01
-32.00	0.781259E 01	0.216211E 01	0.150018E 01	-0.345051E 01
-34.00	0.769146E 01	0.210927E 01	0.147367E 01	-0.336656E 01
-36.00	0.757329E 01	0.205736E 01	0.144788E 01	-0.328407E 01
-38.00	0.745804E 01	0.200636E 01	0.142279E 01	-0.320301E 01
-40.00	0.734564E 01	0.195623E 01	0.139838E 01	-0.312333E 01
-42.00	0.723604E 01	0.190697E 01	0.137464E 01	-0.304498E 01
-44.00	0.712920E 01	0.185853E 01	0.135155E 01	-0.296795E 01
-46.00	0.702508E 01	0.181090E 01	0.132911E 01	-0.289218E 01
-48.00	0.692363E 01	0.176405E 01	0.130729E 01	-0.281765E 01
-50.00	0.682480E 01	0.171798E 01	0.128609E 01	-0.274432E 01
-52.00	0.672857E 01	0.167264E 01	0.126549E 01	-0.267216E 01
-54.00	0.663487E 01	0.162803E 01	0.124548E 01	-0.260113E 01
-56.00	0.654368E 01	0.158411E 01	0.122605E 01	-0.253120E 01
-58.00	0.645496E 01	0.154088E 01	0.120719E 01	-0.246234E 01
-60.00	0.636866E 01	0.149831E 01	0.118888E 01	-0.239452E 01
-62.00	0.628476E 01	0.145638E 01	0.117111E 01	-0.232771E 01
-64.00	0.620322E 01	0.141507E 01	0.115388E 01	-0.226187E 01
-66.00	0.612399E 01	0.137436E 01	0.113717E 01	-0.219699E 01
-68.00	0.604706E 01	0.133424E 01	0.112098E 01	-0.213302E 01
-70.00	0.597238E 01	0.129468E 01	0.110530E 01	-0.206995E 01
-72.00	0.589992E 01	0.125568E 01	0.109011E 01	-0.200773E 01
-74.00	0.582967E 01	0.121720E 01	0.107540E 01	-0.194636E 01
-76.00	0.576158E 01	0.117924E 01	0.106118E 01	-0.188579E 01
-78.00	0.569563E 01	0.114177E 01	0.104742E 01	-0.182601E 01
-80.00	0.563179E 01	0.110479E 01	0.103413E 01	-0.176698E 01
-82.00	0.557003E 01	0.106827E 01	0.102130E 01	-0.170869E 01
-84.00	0.551034E 01	0.103220E 01	0.100891E 01	-0.165110E 01
-86.00	0.545268E 01	0.996556E 00	0.996960E 00	-0.159419E 01
-88.00	0.539703E 01	0.961333E 00	0.985446E 00	-0.153793E 01

-90.00	0.534337E 01	0.926512E 00	0.974361E 00	-0.148231E C1
-92.00	0.529167E 01	0.892077E 00	0.963695E 00	-0.142730E 01
-94.00	0.524192E 01	0.858015E 00	0.953446E 00	-0.137288E 01
-96.00	0.519409E 01	0.824308E 00	0.943605E 00	-0.131901E 01
-98.00	0.514816E 01	0.790944E 00	0.934169E 00	-0.126569E 01
-100.00	0.510412E 01	0.757909E 00	0.925131E 00	-0.121289E 01
-102.00	0.506196E 01	0.725187E 00	0.916486E 00	-0.116058E 01
-104.00	0.502163E 01	0.692766E 00	0.908231E 00	-0.110874E 01
-106.00	0.498314E 01	0.660631E 00	0.900259E 00	-0.105736E 01
-108.00	0.494648E 01	0.628770E 00	0.892867E 00	-0.100640E 01
-110.00	0.491161E 01	0.597169E 00	0.885751E 00	-0.955859E 00
-112.00	0.487854E 01	0.565813E 00	0.879006E 00	-0.905703E 00
-114.00	0.484723E 01	0.534690E 00	0.872629E 00	-0.855915E 00
-116.00	0.481770E 01	0.503788E 00	0.866616E 00	-0.806475E 00
-118.00	0.478992E 01	0.473093E 00	0.860964E 00	-0.757361E 00
-120.00	0.476387E 01	0.442592E 00	0.855671E 00	-0.708554E 00
-122.00	0.473955E 01	0.412273E 00	0.850732E 00	-0.660034E 00
-124.00	0.471695E 01	0.382123E 00	0.846146E 00	-0.611781E 00
-126.00	0.469607E 01	0.352130E 00	0.841909E 00	-0.563776E 00
-128.00	0.467688E 01	0.322282E 00	0.838020E 00	-0.515998E 00
-130.00	0.465939E 01	0.292565E 00	0.834476E 00	-0.468429E 00
-132.00	0.464359E 01	0.262969E 00	0.831276E 00	-0.421049E 00
-134.00	0.462947E 01	0.233480E 00	0.828417E 00	-0.373840E 00
-136.00	0.461701E 01	0.204086E 00	0.825897E 00	-0.326780E 00
-138.00	0.460623E 01	0.174776E 00	0.823717E 00	-0.279853E 00
-140.00	0.459713E 01	0.145538E 00	0.821875E 00	-0.233039E 00
-142.00	0.458967E 01	0.116359E 00	0.820368E 00	-0.186318E 00
-144.00	0.458388E 01	0.872277E-01	0.819197E 00	-0.139673E 00
-146.00	0.457975E 01	0.581320E-01	0.818361E 00	-0.930843E-01
-148.00	0.457726E 01	0.290601E-01	0.817860E 00	-0.465328E-01
-150.00	0.457644E 01	0.000000E 00	0.817693E 00	-0.000000E 00

X/L = 0.10

Y	HORIZONTAL VELOCITY	VERTICAL VELOCITY	HORIZONTAL ACCELERATION	VERTICAL ACCELERATION
14.45	0.955804E 01	0.694712E 01	0.426738E 01	-0.472316E 01
14.00	0.952014E 01	0.691208E 01	0.424707E 01	-0.470013E 01
12.00	0.935491E 01	0.675918E 01	0.425875E 01	-0.459960E 01
10.00	0.919321E 01	0.660937E 01	0.417267E 01	-0.450099E 01
8.00	0.903498E 01	0.646258E 01	0.408876E 01	-0.440424E 01
6.00	0.888016E 01	0.631874E 01	0.400697E 01	-0.430933E 01
4.00	0.872868E 01	0.617776E 01	0.392725E 01	-0.421619E 01
2.00	0.858049E 01	0.603959E 01	0.384956E 01	-0.412480E 01
-0.00	0.843551E 01	0.590414E 01	0.377384E 01	-0.403509E 01
-2.00	0.829368E 01	0.577135E 01	0.370003E 01	-0.394704E 01
-4.00	0.815495E 01	0.564115E 01	0.362811E 01	-0.386061E 01
-6.00	0.801927E 01	0.551346E 01	0.355801E 01	-0.377574E 01
-8.00	0.788659E 01	0.538825E 01	0.348972E 01	-0.369242E 01
-10.00	0.775682E 01	0.526542E 01	0.342316E 01	-0.361059E 01
-12.00	0.762994E 01	0.514493E 01	0.335830E 01	-0.353022E 01
-14.00	0.750590E 01	0.502671E 01	0.329512E 01	-0.345128E 01
-16.00	0.738463E 01	0.491071E 01	0.323355E 01	-0.337372E 01
-18.00	0.726610E 01	0.479687E 01	0.317358E 01	-0.329753E 01
-20.00	0.715025E 01	0.468514E 01	0.311516E 01	-0.322265E 01
-22.00	0.703704E 01	0.457545E 01	0.305826E 01	-0.314907E 01
-24.00	0.692642E 01	0.446776E 01	0.300283E 01	-0.307673E 01
-26.00	0.681835E 01	0.436201E 01	0.294886E 01	-0.300562E 01
-28.00	0.671279E 01	0.425815E 01	0.289630E 01	-0.293571E 01
-30.00	0.660969E 01	0.415615E 01	0.284512E 01	-0.286697E 01
-32.00	0.650901E 01	0.405593E 01	0.279530E 01	-0.279935E 01
-34.00	0.641071E 01	0.395746E 01	0.274680E 01	-0.273284E 01
-36.00	0.631476E 01	0.386069E 01	0.269960E 01	-0.266741E 01
-38.00	0.622113E 01	0.376558E 01	0.265367E 01	-0.260303E 01
-40.00	0.612975E 01	0.367207E 01	0.260897E 01	-0.253967E 01
-42.00	0.604061E 01	0.358013E 01	0.256549E 01	-0.247731E 01
-44.00	0.595366E 01	0.348972E 01	0.252320E 01	-0.241591E 01
-46.00	0.586889E 01	0.340079E 01	0.248207E 01	-0.235547E 01
-48.00	0.578625E 01	0.331330E 01	0.244208E 01	-0.229593E 01
-50.00	0.570570E 01	0.322721E 01	0.240321E 01	-0.223730E 01
-52.00	0.562722E 01	0.314248E 01	0.236543E 01	-0.217953E 01
-54.00	0.555078E 01	0.305908E 01	0.232872E 01	-0.212261E 01
-56.00	0.547635E 01	0.297696E 01	0.229307E 01	-0.206651E 01
-58.00	0.540390E 01	0.289609E 01	0.225844E 01	-0.201121E 01
-60.00	0.533340E 01	0.281643E 01	0.222483E 01	-0.195669E 01
-62.00	0.526482E 01	0.273795E 01	0.219221E 01	-0.190292E 01
-64.00	0.519814E 01	0.266061E 01	0.216056E 01	-0.184989E 01
-66.00	0.513333E 01	0.258439E 01	0.212987E 01	-0.179757E 01
-68.00	0.507038E 01	0.250923E 01	0.210011E 01	-0.174594E 01
-70.00	0.500924E 01	0.243511E 01	0.207128E 01	-0.169497E 01
-72.00	0.494990E 01	0.236200E 01	0.204335E 01	-0.164466E 01
-74.00	0.489234E 01	0.228987E 01	0.201631E 01	-0.159498E 01
-76.00	0.483653E 01	0.221869E 01	0.199015E 01	-0.154591E 01
-78.00	0.478246E 01	0.214842E 01	0.196485E 01	-0.149743E 01
-80.00	0.473010E 01	0.207903E 01	0.194039E 01	-0.144952E 01
-82.00	0.467943E 01	0.201050E 01	0.191677E 01	-0.140217E 01
-84.00	0.463043E 01	0.194279E 01	0.189396E 01	-0.135535E 01
-86.00	0.458309E 01	0.187588E 01	0.187197E 01	-0.130904E 01
-88.00	0.453739E 01	0.180973E 01	0.185076E 01	-0.126323E 01
-90.00	0.449330E 01	0.174423E 01	0.183034E 01	-0.121790E 01
-92.00	0.445082E 01	0.167963E 01	0.181070E 01	-0.117304E 01



-94.00	0.440993E 01	0.161563E 01	0.179181E 01	-0.112862E 01
-96.00	0.437061E 01	0.155227E 01	0.177368E 01	-0.108462E 01
-98.00	0.433284E 01	0.148956E 01	0.175628E 01	-0.104104E 01
-100.00	0.429661E 01	0.142744E 01	0.173962E 01	-0.997850E 00
-102.00	0.426191E 01	0.136591E 01	0.172369E 01	-0.955038E 00
-104.00	0.422873E 01	0.130492E 01	0.170846E 01	-0.912586E 00
-106.00	0.419705E 01	0.124447E 01	0.169394E 01	-0.870479E 00
-108.00	0.416686E 01	0.118452E 01	0.168012E 01	-0.828701E 00
-110.00	0.413815E 01	0.112505E 01	0.166700E 01	-0.787235E 00
-112.00	0.411090E 01	0.106603E 01	0.165455E 01	-0.746065E 00
-114.00	0.408511E 01	0.100745E 01	0.164278E 01	-0.705176E 00
-116.00	0.406078E 01	0.949269E 00	0.163169E 01	-0.664553E 00
-118.00	0.403788E 01	0.891471E 00	0.162126E 01	-0.624180E 00
-120.00	0.401641E 01	0.834032E 00	0.161149E 01	-0.584042E 00
-122.00	0.399636E 01	0.776929E 00	0.160237E 01	-0.544122E 00
-124.00	0.397774E 01	0.720139E 00	0.159390E 01	-0.504408E 00
-126.00	0.396052E 01	0.663638E 00	0.158608E 01	-0.464883E 00
-128.00	0.394469E 01	0.607403E 00	0.157890E 01	-0.425532E 00
-130.00	0.393027E 01	0.551412E 00	0.157236E 01	-0.386341E 00
-132.00	0.391723E 01	0.495643E 00	0.156644E 01	-0.347296E 00
-134.00	0.390558E 01	0.440073E 00	0.156116E 01	-0.308380E 00
-136.00	0.389532E 01	0.384678E 00	0.155651E 01	-0.269580E 00
-138.00	0.388642E 01	0.329438E 00	0.155248E 01	-0.230881E 00
-140.00	0.387891E 01	0.274330E 00	0.154908E 01	-0.192269E 00
-142.00	0.387276E 01	0.219333E 00	0.154630E 01	-0.153729E 00
-144.00	0.386798E 01	0.164423E 00	0.154414E 01	-0.115246E 00
-146.00	0.386457E 01	0.109579E 00	0.154259E 01	-0.768068E-01
-148.00	0.386252E 01	0.547784E-01	0.154166E 01	-0.383963E-01
-150.00	0.386184E 01	0.000000E 00	0.154136E 01	-0.000000E 00

X/L = 0.15

Y	HORIZONTAL VELOCITY	VERTICAL VELOCITY	HORIZONTAL ACCELERATION	VERTICAL ACCELERATION
9.00	0.621550E 01	0.874389E 01	0.543071E 01	-0.282069E 01
8.00	0.616166E 01	0.864024E 01	0.537341E 01	-0.279094E 01
6.00	0.600345E 01	0.845114E 01	0.526931E 01	-0.273646E 01
4.00	0.596716E 01	0.826569E 01	0.516780E 01	-0.268278E 01
2.00	0.587277E 01	0.808382E 01	0.506880E 01	-0.262989E 01
-0.00	0.578023E 01	0.790542E 01	0.497226E 01	-0.257776E 01
-2.00	0.568954E 01	0.773040E 01	0.487811E 01	-0.252638E 01
-4.00	0.560066E 01	0.755868E 01	0.478631E 01	-0.247575E 01
-6.00	0.551357E 01	0.739018E 01	0.469680E 01	-0.242584E 01
-8.00	0.542825E 01	0.722484E 01	0.460952E 01	-0.237665E 01
-10.00	0.534465E 01	0.706255E 01	0.452442E 01	-0.232814E 01
-12.00	0.526277E 01	0.690325E 01	0.444146E 01	-0.228033E 01
-14.00	0.518257E 01	0.674685E 01	0.436057E 01	-0.223319E 01
-16.00	0.510404E 01	0.659330E 01	0.428173E 01	-0.218670E 01
-18.00	0.502715E 01	0.644251E 01	0.420487E 01	-0.214086E 01
-20.00	0.495187E 01	0.629443E 01	0.412996E 01	-0.209566E 01
-22.00	0.487819E 01	0.614896E 01	0.405695E 01	-0.205108E 01
-24.00	0.480609E 01	0.600606E 01	0.398580E 01	-0.200710E 01
-26.00	0.473553E 01	0.586565E 01	0.391647E 01	-0.196372E 01
-28.00	0.466651E 01	0.572768E 01	0.384892E 01	-0.192092E 01
-30.00	0.459900E 01	0.559208E 01	0.378312E 01	-0.187869E 01
-32.00	0.453298E 01	0.545878E 01	0.371901E 01	-0.183703E 01
-34.00	0.446843E 01	0.532773E 01	0.365657E 01	-0.179591E 01
-36.00	0.440533E 01	0.519888E 01	0.359577E 01	-0.175533E 01
-38.00	0.434367E 01	0.507216E 01	0.353657E 01	-0.171527E 01
-40.00	0.428342E 01	0.494750E 01	0.347894E 01	-0.167573E 01
-42.00	0.422456E 01	0.482488E 01	0.342284E 01	-0.163669E 01
-44.00	0.416708E 01	0.470421E 01	0.336824E 01	-0.159814E 01
-46.00	0.411097E 01	0.458547E 01	0.331512E 01	-0.156007E 01
-48.00	0.405620E 01	0.446858E 01	0.326344E 01	-0.152247E 01
-50.00	0.400276E 01	0.435350E 01	0.321318E 01	-0.148533E 01
-52.00	0.395063E 01	0.424019E 01	0.316431E 01	-0.144864E 01
-54.00	0.389979E 01	0.412859E 01	0.311680E 01	-0.141239E 01
-56.00	0.385024E 01	0.401866E 01	0.307063E 01	-0.137656E 01
-58.00	0.380195E 01	0.391034E 01	0.302577E 01	-0.134116E 01
-60.00	0.375492E 01	0.380359E 01	0.298220E 01	-0.130615E 01
-62.00	0.370912E 01	0.369837E 01	0.293990E 01	-0.127155E 01
-64.00	0.366454E 01	0.359462E 01	0.289884E 01	-0.123733E 01
-66.00	0.362117E 01	0.349233E 01	0.285900E 01	-0.120349E 01
-68.00	0.357900E 01	0.339142E 01	0.282036E 01	-0.117001E 01
-70.00	0.353801E 01	0.329186E 01	0.278290E 01	-0.113689E 01
-72.00	0.349819E 01	0.319361E 01	0.274660E 01	-0.110412E 01
-74.00	0.345953E 01	0.309663E 01	0.271144E 01	-0.107168E 01
-76.00	0.342202E 01	0.300089E 01	0.267741E 01	-0.103958E 01
-78.00	0.338564E 01	0.290633E 01	0.264448E 01	-0.100779E 01
-80.00	0.335039E 01	0.281292E 01	0.261264E 01	-0.976311E 00
-82.00	0.331625E 01	0.272063E 01	0.258187E 01	-0.945131E 00
-84.00	0.328321E 01	0.262941E 01	0.255215E 01	-0.914242E 00
-86.00	0.325127E 01	0.253923E 01	0.252348E 01	-0.883634E 00
-88.00	0.322041E 01	0.245004E 01	0.249584E 01	-0.853298E 00
-90.00	0.319062E 01	0.236182E 01	0.246921E 01	-0.823224E 00
-92.00	0.316190E 01	0.227454E 01	0.244357E 01	-0.793405E 00
-94.00	0.313423E 01	0.218814E 01	0.241892E 01	-0.763831E 00
-96.00	0.310761E 01	0.210260E 01	0.239525E 01	-0.734492E 00
-98.00	0.308202E 01	0.201789E 01	0.237253E 01	-0.705380E 00

-100.00	0.305747E 01	0.193397E 01	0.235076E 01	-0.676486E 00
-102.00	0.303394E 01	0.185080E 01	0.232994E 01	-0.647801E 00
-104.00	0.301143E 01	0.176836E 01	0.231004E 01	-0.619317E 00
-106.00	0.298992E 01	0.168661E 01	0.229105E 01	-0.591025E 00
-108.00	0.296942E 01	0.160552E 01	0.227298E 01	-0.562917E 00
-110.00	0.294991E 01	0.152505E 01	0.225581E 01	-0.534983E 00
-112.00	0.293139E 01	0.144518E 01	0.223953E 01	-0.507215E 00
-114.00	0.291386E 01	0.136587E 01	0.222412E 01	-0.479604E 00
-116.00	0.289730E 01	0.128709E 01	0.220960E 01	-0.452143E 00
-118.00	0.288172E 01	0.120881E 01	0.219594E 01	-0.424822E 00
-120.00	0.286711E 01	0.113101E 01	0.218315E 01	-0.397633E 00
-122.00	0.285346E 01	0.105364E 01	0.217121E 01	-0.370568E 00
-124.00	0.284077E 01	0.975683E 00	0.216012E 01	-0.343619E 00
-126.00	0.282904E 01	0.900104E 00	0.214987E 01	-0.316776E 00
-128.00	0.281825E 01	0.823874E 00	0.214046E 01	-0.290032E 00
-130.00	0.280842E 01	0.747964E 00	0.213188E 01	-0.263379E 00
-132.00	0.279953E 01	0.672344E 00	0.212413E 01	-0.236807E 00
-134.00	0.279159E 01	0.596985E 00	0.211721E 01	-0.210310E 00
-136.00	0.278458E 01	0.521857E 00	0.211111E 01	-0.183877E 00
-138.00	0.277852E 01	0.446931E 00	0.210583E 01	-0.157503E 00
-140.00	0.277339E 01	0.372178E 00	0.210137E 01	-0.131177E 00
-142.00	0.276920E 01	0.297570E 00	0.209772E 01	-0.104893E 00
-144.00	0.276594E 01	0.223077E 00	0.209489E 01	-0.786409E-01
-146.00	0.276361E 01	0.148670E 00	0.209286E 01	-0.524137E-01
-148.00	0.276221E 01	0.743206E-01	0.209164E 01	-0.262028E-01
-150.00	0.276175E 01	0.000000E 00	0.209124E 01	-0.000000E 00

X/L = 0.20

Y	HORIZONTAL VELOCITY	VERTICAL VELOCITY	HORIZONTAL ACCELERATION	VERTICAL ACCELERATION
3.25	0.265701E 01	0.927674E 01	0.566384E 01	-0.923884E 00
2.00	0.263659E 01	0.915183E 01	0.559952E 01	-0.917450E 00
-0.00	0.260417E 01	0.895465E 01	0.549844E 01	-0.906965E 00
-2.00	0.257213E 01	0.876104E 01	0.539976E 01	-0.896272E 00
-4.00	0.254047E 01	0.857084E 01	0.530342E 01	-0.885388E 00
-6.00	0.250921E 01	0.838404E 01	0.520937E 01	-0.874325E 00
-8.00	0.247834E 01	0.820056E 01	0.511757E 01	-0.863097E 00
-10.00	0.244787E 01	0.802030E 01	0.502796E 01	-0.851715E 00
-12.00	0.241780E 01	0.784318E 01	0.494049E 01	-0.840191E 00
-14.00	0.238815E 01	0.766913E 01	0.485512E 01	-0.828536E 00
-16.00	0.235892E 01	0.749809E 01	0.477180E 01	-0.816761E 00
-18.00	0.233010E 01	0.732996E 01	0.469051E 01	-0.804876E 00
-20.00	0.230171E 01	0.716469E 01	0.461118E 01	-0.792891E 00
-22.00	0.227375E 01	0.700222E 01	0.453378E 01	-0.780815E 00
-24.00	0.224622E 01	0.684243E 01	0.445827E 01	-0.768655E 00
-26.00	0.221912E 01	0.668532E 01	0.438462E 01	-0.756422E 00
-28.00	0.219246E 01	0.653078E 01	0.431278E 01	-0.744122E 00
-30.00	0.216623E 01	0.637878E 01	0.424272E 01	-0.731763E 00
-32.00	0.214045E 01	0.622922E 01	0.417440E 01	-0.719351E 00
-34.00	0.211511E 01	0.608206E 01	0.410780E 01	-0.706893E 00
-36.00	0.209021E 01	0.593725E 01	0.404287E 01	-0.694396E 00
-38.00	0.206576E 01	0.579471E 01	0.397959E 01	-0.681865E 00
-40.00	0.204175E 01	0.565439E 01	0.391792E 01	-0.669306E 00
-42.00	0.201819E 01	0.551623E 01	0.385784E 01	-0.656725E 00
-44.00	0.199507E 01	0.538018E 01	0.379931E 01	-0.644124E 00
-46.00	0.197241E 01	0.524618E 01	0.374231E 01	-0.631510E 00
-48.00	0.195019E 01	0.511418E 01	0.368682E 01	-0.618887E 00
-50.00	0.192842E 01	0.498413E 01	0.363279E 01	-0.606258E 00
-52.00	0.190710E 01	0.485597E 01	0.358021E 01	-0.593628E 00
-54.00	0.188623E 01	0.472966E 01	0.352905E 01	-0.581000E 00
-56.00	0.186581E 01	0.460513E 01	0.347929E 01	-0.568376E 00
-58.00	0.184583E 01	0.448235E 01	0.343091E 01	-0.555760E 00
-60.00	0.182631E 01	0.436127E 01	0.338387E 01	-0.543155E 00
-62.00	0.180723E 01	0.424183E 01	0.333817E 01	-0.530562E 00
-64.00	0.178860E 01	0.412400E 01	0.329377E 01	-0.517986E 00
-66.00	0.177041E 01	0.400772E 01	0.325066E 01	-0.505427E 00
-68.00	0.175268E 01	0.389295E 01	0.320882E 01	-0.492887E 00
-70.00	0.173538E 01	0.377964E 01	0.316823E 01	-0.480368E 00
-72.00	0.171853E 01	0.366776E 01	0.312886E 01	-0.467871E 00
-74.00	0.170213E 01	0.355725E 01	0.309071E 01	-0.455399E 00
-76.00	0.168617E 01	0.344808E 01	0.305375E 01	-0.442951E 00
-78.00	0.167064E 01	0.334020E 01	0.301796E 01	-0.430530E 00
-80.00	0.165557E 01	0.323357E 01	0.298334E 01	-0.418136E 00
-82.00	0.164093E 01	0.312815E 01	0.294986E 01	-0.405769E 00
-84.00	0.162673E 01	0.302390E 01	0.291751E 01	-0.393431E 00
-86.00	0.161296E 01	0.292078E 01	0.288627E 01	-0.381120E 00
-88.00	0.159964E 01	0.281875E 01	0.285614E 01	-0.368840E 00
-90.00	0.158675E 01	0.271777E 01	0.282709E 01	-0.356588E 00
-92.00	0.157429E 01	0.261781E 01	0.279911E 01	-0.344365E 00
-94.00	0.156227E 01	0.251882E 01	0.277220E 01	-0.332173E 00
-96.00	0.155069E 01	0.242077E 01	0.274633E 01	-0.320008E 00
-98.00	0.153953E 01	0.232362E 01	0.272151E 01	-0.307873E 00
-100.00	0.152880E 01	0.222733E 01	0.269771E 01	-0.295767E 00
-102.00	0.151851E 01	0.213187E 01	0.267492E 01	-0.283688E 00
-104.00	0.150864E 01	0.203720E 01	0.265314E 01	-0.271637E 00

-106.00	0.149920E 01	0.194329F 01	0.263236E 01	-0.259614E 00
-108.00	0.149019E 01	0.185010E 01	0.261256E 01	-0.247617E 00
-110.00	0.148160E 01	0.175759E 01	0.259374E 01	-0.235645E 00
-112.00	0.147344E 01	0.166574E 01	0.257589E 01	-0.223699E 00
-114.00	0.146570E 01	0.157450E 01	0.255900E 01	-0.211776E 00
-116.00	0.145839E 01	0.148385E 01	0.254307E 01	-0.199876E 00
-118.00	0.145150E 01	0.139375E 01	0.252808E 01	-0.187999E 00
-120.00	0.144503E 01	0.130416E 01	0.251404E 01	-0.176143E 00
-122.00	0.143898E 01	0.121506E 01	0.250093E 01	-0.164306E 00
-124.00	0.143335E 01	0.112640E 01	0.248875E 01	-0.152489E 00
-126.00	0.142814E 01	0.103816E 01	0.247749E 01	-0.140689E 00
-128.00	0.142335E 01	0.950305E 00	0.246715E 01	-0.128906E 00
-130.00	0.141898E 01	0.862801E 00	0.245772E 01	-0.117137E 00
-132.00	0.141502E 01	0.775615E 00	0.244921E 01	-0.105384E 00
-134.00	0.141149E 01	0.688716E 00	0.244160E 01	-0.936421E-01
-136.00	0.140837E 01	0.602072E 00	0.243489E 01	-0.819117E-01
-138.00	0.140566E 01	0.515649E 00	0.242909E 01	-0.701915E-01
-140.00	0.140338E 01	0.429417E 00	0.242418E 01	-0.584797E-01
-142.00	0.140151E 01	0.343344E 00	0.242017E 01	-0.467752E-01
-144.00	0.140005E 01	0.257397E 00	0.241705E 01	-0.350763E-01
-146.00	0.139902E 01	0.171545E 00	0.241482E 01	-0.233818E-01
-148.00	0.139839E 01	0.857568E-01	0.241348E 01	-0.116902E-01
-150.00	0.139819E 01	0.000000E 00	0.241304E 01	-0.000000E 00

X/L =0.25

Y	HORIZONTAL VELOCITY	VERTICAL VELOCITY	HORIZONTAL ACCELERATION	VERTICAL ACCELERATION
-2.00	-0.655505E 00	0.879811E 01	0.525557E 01	0.680865E 00
-4.00	-0.634037E 00	0.863083E 01	0.517757E 01	0.658193E 00
-6.00	-0.611080E 00	0.844834E 01	0.509291E 01	0.633934E 00
-8.00	-0.588971E 00	0.826884E 01	0.501010E 01	0.610554E 00
-10.00	-0.567677E 00	0.809224E 01	0.492909E 01	0.588018E 00
-12.00	-0.547169E 00	0.791849E 01	0.484987E 01	0.566297E 00
-14.00	-0.527419E 00	0.774752E 01	0.477239E 01	0.545361E 00
-16.00	-0.508399E 00	0.757927E 01	0.469662E 01	0.525179E 00
-18.00	-0.490083E 00	0.741369E 01	0.462254E 01	0.505726E 00
-20.00	-0.472447E 00	0.725072E 01	0.455012E 01	0.486973E 00
-22.00	-0.455465E 00	0.709028E 01	0.447933E 01	0.468894E 00
-24.00	-0.439114E 00	0.693233E 01	0.441014E 01	0.451465E 00
-26.00	-0.423370E 00	0.677682E 01	0.434252E 01	0.434660E 00
-28.00	-0.408213E 00	0.662367E 01	0.427645E 01	0.418458E 00
-30.00	-0.393623E 00	0.647286E 01	0.421191E 01	0.402836E 00
-32.00	-0.379576E 00	0.632431E 01	0.414887E 01	0.387772E 00
-34.00	-0.366056E 00	0.617797E 01	0.408730E 01	0.373244E 00
-36.00	-0.353042E 00	0.603379E 01	0.402718E 01	0.359234E 00
-38.00	-0.340518E 00	0.589173E 01	0.396849E 01	0.345721E 00
-40.00	-0.328465E 00	0.575172E 01	0.391121E 01	0.332687E 00
-42.00	-0.316867E 00	0.561373E 01	0.385531E 01	0.320114E 00
-44.00	-0.305708E 00	0.547770E 01	0.380078E 01	0.307984E 00
-46.00	-0.294973E 00	0.534358E 01	0.374759E 01	0.296281E 00
-48.00	-0.284646E 00	0.521133E 01	0.369572E 01	0.284988E 00
-50.00	-0.274713E 00	0.508090E 01	0.364516E 01	0.274089E 00
-52.00	-0.265161E 00	0.495224E 01	0.359588E 01	0.263571E 00
-54.00	-0.255976E 00	0.482531E 01	0.354787E 01	0.253417E 00
-56.00	-0.247145E 00	0.470006E 01	0.350111E 01	0.243615E 00
-58.00	-0.238657E 00	0.457646E 01	0.345559E 01	0.234150E 00
-60.00	-0.230500E 00	0.445445E 01	0.341127E 01	0.225009E 00
-62.00	-0.222661E 00	0.433399E 01	0.336816E 01	0.216180E 00
-64.00	-0.215132E 00	0.421505E 01	0.332623E 01	0.207650E 00
-66.00	-0.207900E 00	0.409758E 01	0.328546E 01	0.199408E 00
-68.00	-0.200956E 00	0.398153E 01	0.324585E 01	0.191442E 00
-70.00	-0.194291E 00	0.386687E 01	0.320738E 01	0.183741E 00
-72.00	-0.187894E 00	0.375356E 01	0.317003E 01	0.176295E 00
-74.00	-0.181758E 00	0.364155E 01	0.313379E 01	0.169093E 00
-76.00	-0.175873E 00	0.353081E 01	0.309865E 01	0.162125E 00
-78.00	-0.170232E 00	0.342131E 01	0.306459E 01	0.155382E 00
-80.00	-0.164827E 00	0.331300E 01	0.303160E 01	0.148853E 00
-82.00	-0.159650E 00	0.320583E 01	0.299968E 01	0.142531E 00
-84.00	-0.154695E 00	0.309979E 01	0.296880E 01	0.136407E 00
-86.00	-0.149953E 00	0.299482E 01	0.293896E 01	0.130471E 00
-88.00	-0.145419E 00	0.289089E 01	0.291015E 01	0.124716E 00
-90.00	-0.141087E 00	0.278797E 01	0.288235E 01	0.119134E 00
-92.00	-0.136950E 00	0.268602E 01	0.285555E 01	0.113717E 00
-94.00	-0.133003E 00	0.258501E 01	0.282976E 01	0.108458E 00
-96.00	-0.129240E 00	0.248489E 01	0.280495E 01	0.103348E 00
-98.00	-0.125656E 00	0.238564E 01	0.278112E 01	0.983819E-01
-100.00	-0.122246E 00	0.228721E 01	0.275826E 01	0.935518E-01
-102.00	-0.119005E 00	0.218958E 01	0.273636E 01	0.888513E-01
-104.00	-0.115930E 00	0.209272E 01	0.271541E 01	0.842739E-01
-106.00	-0.113014E 00	0.199658E 01	0.269541E 01	0.798132E-01
-108.00	-0.110256E 00	0.190114E 01	0.267634E 01	0.754631E-01
-110.00	-0.107650E 00	0.180635E 01	0.265821E 01	0.712175E-01

-112.00	-0.105193E 00	0.171220E 01	0.264100E 01	0.670705E-01
-114.00	-0.102882E 00	0.161864E 01	0.262471E 01	0.630164E-01
-116.00	-0.100713E 00	0.152564E 01	0.260934E 01	0.590497E-01
-118.00	-0.986838E-01	0.143317E 01	0.259487E 01	0.551647E-01
-120.00	-0.967914E-01	0.134120E 01	0.258131E 01	0.513560E-01
-122.00	-0.950330E-01	0.124970E 01	0.256864E 01	0.476186E-01
-124.00	-0.934062E-01	0.115863E 01	0.255687E 01	0.439470E-01
-126.00	-0.919088E-01	0.106796E 01	0.254599E 01	0.403364E-01
-128.00	-0.905387E-01	0.977666E 00	0.253598E 01	0.367816E-01
-130.00	-0.892940E-01	0.887710E 00	0.252687E 01	0.332777E-01
-132.00	-0.881730E-01	0.798062E 00	0.251863E 01	0.298200E-01
-134.00	-0.871741E-01	0.708692E 00	0.251126E 01	0.264035E-01
-136.00	-0.862960E-01	0.619568E 00	0.250477E 01	0.230237E-01
-138.00	-0.855374E-01	0.530659E 00	0.249915E 01	0.196756E-01
-140.00	-0.848973E-01	0.441934E 00	0.249440E 01	0.163549E-01
-142.00	-0.843747E-01	0.353363E 00	0.249051E 01	0.130568E-01
-144.00	-0.839690E-01	0.264915E 00	0.248749E 01	0.977682E-02
-146.00	-0.836797E-01	0.176559E 00	0.248533E 01	0.651038E-02
-148.00	-0.835062E-01	0.882642E-01	0.248403E 01	0.325294E-02
-150.00	-0.834485E-01	0.000000E 00	0.248360E 01	-0.000000E 00

X/L = 0.30

Y	HORIZONTAL VELOCITY	VERTICAL VELOCITY	HORIZONTAL ACCELERATION	VERTICAL ACCELERATION
-6.00	-0.347107E 01	0.760922E 01	0.443111E 01	0.188027E 01
-8.00	-0.343130E 01	0.751517E 01	0.439250E 01	0.185099E 01
-10.00	-0.336637E 01	0.736020E 01	0.432911E 01	0.180314E 01
-12.00	-0.330313E 01	0.720747E 01	0.426688E 01	0.175647E 01
-14.00	-0.324152E 01	0.705693E 01	0.420583E 01	0.171094E 01
-16.00	-0.318151E 01	0.690853E 01	0.414593E 01	0.166651E 01
-18.00	-0.312306E 01	0.676224E 01	0.408718E 01	0.162315E 01
-20.00	-0.306614E 01	0.661802E 01	0.402956E 01	0.158083E 01
-22.00	-0.301070E 01	0.647524E 01	0.397307E 01	0.153950E 01
-24.00	-0.295671E 01	0.633563E 01	0.391769E 01	0.149914E 01
-26.00	-0.290414E 01	0.619738E 01	0.386342E 01	0.145971E 01
-28.00	-0.285295E 01	0.606103E 01	0.381023E 01	0.142120E 01
-30.00	-0.280312E 01	0.592656E 01	0.375814E 01	0.138356E 01
-32.00	-0.275461E 01	0.579392E 01	0.370712E 01	0.134678E 01
-34.00	-0.270739E 01	0.566307E 01	0.365716E 01	0.131081E 01
-36.00	-0.266143E 01	0.553398E 01	0.360825E 01	0.127564E 01
-38.00	-0.261672E 01	0.540661E 01	0.356039E 01	0.124125E 01
-40.00	-0.257323E 01	0.528092E 01	0.351356E 01	0.120760E 01
-42.00	-0.253088E 01	0.515688E 01	0.346775E 01	0.117468E 01
-44.00	-0.248971E 01	0.503444E 01	0.342296E 01	0.114245E 01
-46.00	-0.244967E 01	0.491356E 01	0.337918E 01	0.111090E 01
-48.00	-0.241075E 01	0.479426E 01	0.333639E 01	0.108000E 01
-50.00	-0.237291E 01	0.467645E 01	0.329459E 01	0.104974E 01
-52.00	-0.233613E 01	0.456010E 01	0.325378E 01	0.102009E 01
-54.00	-0.230040E 01	0.444518E 01	0.321393E 01	0.991035E 00
-56.00	-0.226569E 01	0.433166E 01	0.317504E 01	0.962550E 00
-58.00	-0.223198E 01	0.421951E 01	0.313710E 01	0.934620E 00
-60.00	-0.219925E 01	0.410868E 01	0.310011E 01	0.907225E 00
-62.00	-0.216749E 01	0.399916E 01	0.306406E 01	0.880346E 00
-64.00	-0.213668E 01	0.389090E 01	0.302893E 01	0.853968E 00
-66.00	-0.210679E 01	0.378387E 01	0.299472E 01	0.828074E 00
-68.00	-0.207782E 01	0.367804E 01	0.296143E 01	0.802644E 00
-70.00	-0.204974E 01	0.357338E 01	0.292904E 01	0.777665E 00
-72.00	-0.202254E 01	0.346986E 01	0.289755E 01	0.753120E 00
-74.00	-0.199621E 01	0.336743E 01	0.286695E 01	0.728995E 00
-76.00	-0.197073E 01	0.326608E 01	0.283723E 01	0.705273E 00
-78.00	-0.194608E 01	0.316577E 01	0.280839E 01	0.681941E 00
-80.00	-0.192226E 01	0.306647E 01	0.278042E 01	0.658984E 00
-82.00	-0.189924E 01	0.296815E 01	0.275332E 01	0.636388E 00
-84.00	-0.187702E 01	0.287078E 01	0.272707E 01	0.614140E 00
-86.00	-0.185559E 01	0.277432E 01	0.270167E 01	0.592226E 00
-88.00	-0.183492E 01	0.267875E 01	0.267711E 01	0.570633E 00
-90.00	-0.181503E 01	0.258403E 01	0.265340E 01	0.549349E 00
-92.00	-0.179588E 01	0.249015E 01	0.263051E 01	0.528362E 00
-94.00	-0.177747E 01	0.239707E 01	0.260846E 01	0.507659E 00
-96.00	-0.175979E 01	0.230475E 01	0.258723E 01	0.487228E 00
-98.00	-0.174284E 01	0.221317E 01	0.256681E 01	0.467057E 00
-100.00	-0.172660E 01	0.212231E 01	0.254721E 01	0.447135E 00
-102.00	-0.171106E 01	0.203212E 01	0.252841E 01	0.427451E 00
-104.00	-0.169621E 01	0.194259E 01	0.251042E 01	0.407994E 00
-106.00	-0.168206E 01	0.185369E 01	0.249323E 01	0.388753E 00
-108.00	-0.166858E 01	0.176538E 01	0.247682E 01	0.369718E 00
-110.00	-0.165578E 01	0.167765E 01	0.246121E 01	0.350877E 00
-112.00	-0.164364E 01	0.159045E 01	0.244639E 01	0.332220E 00
-114.00	-0.163216E 01	0.150376E 01	0.243235E 01	0.213738E 00



-116.00	-0.162134E 01	0.141756F 01	0.241908E 01	0.295420E 00
-118.00	-0.161116E 01	0.133182E 01	0.240659E 01	0.277256E 00
-120.00	-0.160163E 01	0.124651E 01	0.239488E 01	0.259238E 00
-122.00	-0.159274E 01	0.116160E 01	0.238393E 01	0.241354E 00
-124.00	-0.158448E 01	0.107707E 01	0.237375E 01	0.223596E 00
-126.00	-0.157685E 01	0.992880E 00	0.236434E 01	0.205954E 00
-128.00	-0.156984E 01	0.909015E 00	0.235569E 01	0.188419E 00
-130.00	-0.156345E 01	0.825444E 00	0.234779E 01	0.170981E 00
-132.00	-0.155768E 01	0.742140E 00	0.234066E 01	0.153633E 00
-134.00	-0.155253E 01	0.659076E 00	0.233428E 01	0.136363E 00
-136.00	-0.154799E 01	0.576226E 00	0.232865E 01	0.119164E 00
-138.00	-0.154406E 01	0.493562E 00	0.232378E 01	0.102027E 00
-140.00	-0.154074E 01	0.411057E 00	0.231966E 01	0.849423E-01
-142.00	-0.153802E 01	0.328686E 00	0.231629E 01	0.679013E-01
-144.00	-0.153591E 01	0.246421E 00	0.231367E 01	0.508954E-01
-146.00	-0.153441E 01	0.164237E 00	0.231180E 01	0.339157E-01
-148.00	-0.153350E 01	0.821052E-01	0.231068E 01	0.169535E-01
-150.00	-0.153320E 01	0.000000E 00	0.231031E 01	-0.000000E 00

X/L = 0.35

Y	HORIZONTAL VELOCITY	VERTICAL VELOCITY	HORIZONTAL ACCELERATION	VERTICAL ACCELERATION
-10.44	-0.567465E 01	0.596819E 01	0.338441E 01	0.267809E 01
-12.00	-0.560093E 01	0.587463E 01	0.335154E 01	0.263032E 01
-14.00	-0.550952E 01	0.575627E 01	0.331000E 01	0.257024E 01
-16.00	-0.541824E 01	0.563927E 01	0.326904E 01	0.251128E 01
-18.00	-0.533002E 01	0.552392E 01	0.322866E 01	0.245341E 01
-20.00	-0.524385E 01	0.540990E 01	0.318888E 01	0.239662E 01
-22.00	-0.515968E 01	0.529727E 01	0.314970E 01	0.234086E 01
-24.00	-0.507747E 01	0.518602E 01	0.311112E 01	0.228611E 01
-26.00	-0.499718E 01	0.507614E 01	0.307315E 01	0.223235E 01
-28.00	-0.491979E 01	0.496760E 01	0.303579E 01	0.217954E 01
-30.00	-0.484227E 01	0.486037E 01	0.299905E 01	0.212766E 01
-32.00	-0.476757E 01	0.475444E 01	0.296292E 01	0.207668E 01
-34.00	-0.469466E 01	0.464978E 01	0.292742E 01	0.202658E 01
-36.00	-0.462352E 01	0.454637E 01	0.289254E 01	0.197734E 01
-38.00	-0.455412E 01	0.444419E 01	0.285829E 01	0.192894E 01
-40.00	-0.448641E 01	0.434322E 01	0.282466E 01	0.188134E 01
-42.00	-0.442039E 01	0.424343E 01	0.279166E 01	0.183453E 01
-44.00	-0.435602E 01	0.414480E 01	0.275929E 01	0.178848E 01
-46.00	-0.429327E 01	0.404731E 01	0.272755E 01	0.174318E 01
-48.00	-0.423211E 01	0.395093E 01	0.269644E 01	0.169860E 01
-50.00	-0.417254E 01	0.385565E 01	0.266597E 01	0.165473E 01
-52.00	-0.411450E 01	0.376145E 01	0.263613E 01	0.161154E 01
-54.00	-0.405799E 01	0.366829E 01	0.260691E 01	0.156901E 01
-56.00	-0.400298E 01	0.357616E 01	0.257833E 01	0.152712E 01
-58.00	-0.394944E 01	0.348504E 01	0.255038E 01	0.148587E 01
-60.00	-0.389737E 01	0.339489E 01	0.252306E 01	0.144521E 01
-62.00	-0.384672E 01	0.330570E 01	0.249637E 01	0.140515E 01
-64.00	-0.379749E 01	0.321746E 01	0.247031E 01	0.136566E 01
-66.00	-0.374965E 01	0.313013E 01	0.244487E 01	0.132672E 01
-68.00	-0.370319E 01	0.304368E 01	0.242007E 01	0.128832E 01
-70.00	-0.365808E 01	0.295812E 01	0.239588E 01	0.125045E 01
-72.00	-0.361431E 01	0.287339E 01	0.237233E 01	0.121307E 01
-74.00	-0.357185E 01	0.278950E 01	0.234939E 01	0.117619E 01
-76.00	-0.353071E 01	0.270641E 01	0.232708E 01	0.113977E 01
-78.00	-0.349085E 01	0.262410E 01	0.230538E 01	0.110382E 01
-80.00	-0.345225E 01	0.254255E 01	0.228431E 01	0.106831E 01
-82.00	-0.341491E 01	0.246174E 01	0.226385E 01	0.103322E 01
-84.00	-0.337881E 01	0.238164E 01	0.224401E 01	0.998545E 00
-86.00	-0.334394E 01	0.230224E 01	0.222479E 01	0.964268E 00
-88.00	-0.331028E 01	0.222351E 01	0.220617E 01	0.930375E 00
-90.00	-0.327781E 01	0.214543E 01	0.218817E 01	0.896852E 00
-92.00	-0.324653E 01	0.206798E 01	0.217077E 01	0.863685E 00
-94.00	-0.321642E 01	0.199114E 01	0.215399E 01	0.830860E 00
-96.00	-0.318748E 01	0.191488E 01	0.213780E 01	0.798363E 00
-98.00	-0.315968E 01	0.183919E 01	0.212223E 01	0.766182E 00
-100.00	-0.313302E 01	0.176404E 01	0.210725E 01	0.734303E 00
-102.00	-0.310749E 01	0.168941E 01	0.209288E 01	0.702713E 00
-104.00	-0.308307E 01	0.161529E 01	0.207911E 01	0.671400E 00
-106.00	-0.305976E 01	0.154164E 01	0.206594E 01	0.640352E 00
-108.00	-0.303755E 01	0.146845E 01	0.205336E 01	0.609555E 00
-110.00	-0.301644E 01	0.139569E 01	0.204137E 01	0.578997E 00
-112.00	-0.299640E 01	0.132335E 01	0.202998E 01	0.548666E 00
-114.00	-0.297744E 01	0.125141E 01	0.201919E 01	0.518550E 00
-116.00	-0.295954E 01	0.117983E 01	0.200898E 01	0.488637E 00
-118.00	-0.294270E 01	0.110861E 01	0.199937E 01	0.458915E 00

-120.00	-0.292692E 01	0.103773E 01	0.199034E 01	0.429372E 00
-122.00	-0.291219E 01	0.967147E 00	0.198190E 01	0.399998E 00
-124.00	-0.289849E 01	0.896858E 00	0.197405E 01	0.370779E 00
-126.00	-0.288583E 01	0.826838E 00	0.196678E 01	0.341705E 00
-128.00	-0.287420E 01	0.757065E 00	0.196010E 01	0.312764E 00
-130.00	-0.286360E 01	0.687519E 00	0.195401E 01	0.283945E 00
-132.00	-0.285402E 01	0.618180E 00	0.194849E 01	0.255236E 00
-134.00	-0.284546E 01	0.549026E 00	0.194356E 01	0.226627E 00
-136.00	-0.283791E 01	0.480037E 00	0.193921E 01	0.198106E 00
-138.00	-0.283138E 01	0.411193E 00	0.193544E 01	0.169663E 00
-140.00	-0.282586E 01	0.342472E 00	0.193225E 01	0.141285E 00
-142.00	-0.282134E 01	0.273854E 00	0.192965E 01	0.112962E 00
-144.00	-0.281783E 01	0.205318E 00	0.192762E 01	0.846832E-01
-146.00	-0.281532E 01	0.136845E 00	0.192617E 01	0.564372E-01
-148.00	-0.281381E 01	0.684121E-01	0.192530E 01	0.282131E-01
-150.00	-0.281332E 01	0.000000E 00	0.192501E 01	-0.000000E 00

X/L = 0.40

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-12.00	-0.723019E 01	0.407228E 01	0.225530E 01	0.314394E C1
-14.00	-0.717992E 01	0.403613E 01	0.224454E 01	0.311422E 01
-16.00	-0.707041E 01	0.395679E 01	0.222087E 01	0.304914E 01
-18.00	-0.696319E 01	0.397828E 01	0.219737E 01	0.298496E 01
-20.00	-0.685825E 01	0.380061E 01	0.217408E 01	0.292168E 01
-22.00	-0.675553E 01	0.372376E 01	0.215100E 01	0.285927E 01
-24.00	-0.665502E 01	0.364773E 01	0.212815E 01	0.279770E 01
-26.00	-0.655668E 01	0.357250E 01	0.210554E 01	0.273698E 01
-28.00	-0.646048E 01	0.349808E 01	0.208317E 01	0.267708E 01
-30.00	-0.636640E 01	0.342445E 01	0.206106E 01	0.261800E 01
-32.00	-0.627441E 01	0.335159E 01	0.203922E 01	0.255969E 01
-34.00	-0.618446E 01	0.327951E 01	0.201765E 01	0.250216E 01
-36.00	-0.609656E 01	0.320819E 01	0.199636E 01	0.244539E 01
-38.00	-0.601066E 01	0.313762E 01	0.197538E 01	0.238936E 01
-40.00	-0.592673E 01	0.306779E 01	0.195469E 01	0.233405E 01
-42.00	-0.584476E 01	0.299869E 01	0.193431E 01	0.227946E 01
-44.00	-0.576471E 01	0.293031E 01	0.191425E 01	0.222557E 01
-46.00	-0.568657E 01	0.286263E 01	0.189450E 01	0.217235E 01
-48.00	-0.561031E 01	0.279566E 01	0.187509E 01	0.211980E 01
-50.00	-0.553591E 01	0.272936E 01	0.185600E 01	0.206789E 01
-52.00	-0.546333E 01	0.266374E 01	0.183725E 01	0.201663E 01
-54.00	-0.539257E 01	0.259878E 01	0.181884E 01	0.196599E 01
-56.00	-0.532359E 01	0.253446E 01	0.180077E 01	0.191594E 01
-58.00	-0.525639E 01	0.247079E 01	0.178305E 01	0.186649E 01
-60.00	-0.519093E 01	0.240773E 01	0.176569E 01	0.181762E 01
-62.00	-0.512720E 01	0.234529E 01	0.174868E 01	0.176931E 01
-64.00	-0.506517E 01	0.228344E 01	0.173203E 01	0.172155E 01
-66.00	-0.500483E 01	0.222219E 01	0.171574E 01	0.167432E 01
-68.00	-0.494617E 01	0.216150E 01	0.169982E 01	0.162761E 01
-70.00	-0.488915E 01	0.210137E 01	0.168427E 01	0.158141E 01
-72.00	-0.483376E 01	0.204179E 01	0.166908E 01	0.153570E 01
-74.00	-0.477999E 01	0.198274E 01	0.165426E 01	0.149047E 01
-76.00	-0.472783E 01	0.192421E 01	0.163982E 01	0.144571E 01
-78.00	-0.467724E 01	0.186618E 01	0.162576E 01	0.140140E 01
-80.00	-0.462822E 01	0.180866E 01	0.161207E 01	0.135752E 01
-82.00	-0.458075E 01	0.175161E 01	0.159875E 01	0.131408E 01
-84.00	-0.453482E 01	0.169502E 01	0.158582E 01	0.127104E 01
-86.00	-0.449041E 01	0.163889E 01	0.157327E 01	0.122840E 01
-88.00	-0.444750E 01	0.158320E 01	0.156110E 01	0.118615E 01
-90.00	-0.440610E 01	0.152793E 01	0.154931E 01	0.114427E 01
-92.00	-0.436617E 01	0.147308E 01	0.153790E 01	0.110275E 01
-94.00	-0.432772E 01	0.141863E 01	0.152688E 01	0.106158E 01
-96.00	-0.429072E 01	0.136456E 01	0.151624E 01	0.102075E 01
-98.00	-0.425517E 01	0.131086E 01	0.150598E 01	0.980234E 00
-100.00	-0.422105E 01	0.125752E 01	0.149611E 01	0.940030E 00
-102.00	-0.418835E 01	0.120452E 01	0.148663E 01	0.900123E 00
-104.00	-0.415707E 01	0.115185E 01	0.147753E 01	0.860500E 00
-106.00	-0.412719E 01	0.109950E 01	0.146882E 01	0.821150E 00
-108.00	-0.409870E 01	0.104745E 01	0.146050E 01	0.782060E 00
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-112.00	-0.404588E 01	0.944210E 00	0.144501E 01	0.704611E 00
-114.00	-0.402152E 01	0.892987E 00	0.143785E 01	0.666229E 00
-116.00	-0.399853E 01	0.842013E 00	0.143107E 01	0.628057E 00
-118.00	-0.397683E 01	0.791272E 00	0.142468E 01	0.590085E 00
-120.00	-0.395658E 01	0.740751E 00	0.141868E 01	0.552301E 00

-122.00	-0.393762E 01	0.690436E 00	0.141307E 01	0.514691E 00
-124.00	-0.392000E 01	0.640315E 00	0.140784E 01	0.477246E 00
-126.00	-0.390371E 01	0.590372E 00	0.140300E 01	0.439953E 00
-128.00	-0.388873E 01	0.540594E 00	0.139855E 01	0.402799E 00
-130.00	-0.387507E 01	0.490968E 00	0.139448E 01	0.365774E 00
-132.00	-0.386273E 01	0.441479E 00	0.139081E 01	0.328865E 00
-134.00	-0.385170E 01	0.392114E 00	0.138752E 01	0.292061E 00
-136.00	-0.384197E 01	0.342859E 00	0.138461E 01	0.255350E 00
-138.00	-0.383355E 01	0.293700E 00	0.138210E 01	0.218720E 00
-140.00	-0.382643E 01	0.244624E 00	0.137997E 01	0.182161E 00
-142.00	-0.382060E 01	0.195617E 00	0.137822E 01	0.145659E 00
-144.00	-0.381608E 01	0.146664E 00	0.137687E 01	0.109204E 00
-146.00	-0.381284E 01	0.977533E-01	0.137590E 01	0.727831E-01
-148.00	-0.381090E 01	0.488698E-01	0.137532E 01	0.363857E-01
-150.00	-0.381026E 01	0.000000E 00	0.137513E 01	-0.000000E 00

X/L =0.45

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-16.00	-0.807201E 01	0.203193E 01	0.111414E 01	0.332977E 01
-18.00	-0.795485E 01	0.199252F 01	0.110384E 01	0.326412E 01
-20.00	-0.784001E 01	0.195348E 01	0.109356E 01	0.319914E 01
-22.00	-0.772747E 01	0.191480E 01	0.108331E 01	0.313483E 01
-24.00	-0.761720E 01	0.187648F 01	0.107311E 01	0.307117E 01
-26.00	-0.750918E 01	0.183853E 01	0.106296E 01	0.300818E 01
-28.00	-0.740339E 01	0.180093E 01	0.105287E 01	0.294584E 01
-30.00	-0.729981E 01	0.176370E 01	0.104284E 01	0.288414E 01
-32.00	-0.719840E 01	0.172681E 01	0.103290E 01	0.282307E 01
-34.00	-0.709915E 01	0.169028E 01	0.102303F 01	0.276263E 01
-36.00	-0.700204E 01	0.165410F 01	0.101326F 01	0.270282E 01
-38.00	-0.690705E 01	0.161827F 01	0.100359E 01	0.264361E 01
-40.00	-0.681415E 01	0.158277E 01	0.994016E 00	0.258502E 01
-42.00	-0.672331E 01	0.154762E 01	0.984554E 00	0.252702E 01
-44.00	-0.663453F 01	0.151280E 01	0.975206E 00	0.246961E 01
-46.00	-0.654778E 01	0.147830E 01	0.965979F 00	0.241278E 01
-48.00	-0.646304E 01	0.144414F 01	0.956876E 00	0.235652E 01
-50.00	-0.638029F 01	0.141029E 01	0.947903E 00	0.230083E 01
-52.00	-0.629951E 01	0.137677E 01	0.939063E 00	0.224568E 01
-54.00	-0.622068F 01	0.134355F 01	0.930360E 00	0.219108E 01
-56.00	-0.614377E 01	0.131064F 01	0.921799E 00	0.213701E 01
-58.00	-0.606879E 01	0.127804E 01	0.913384E 00	0.208347E 01
-60.00	-0.599569F 01	0.124572F 01	0.905116F 00	0.203044E 01
-62.00	-0.592447F 01	0.121370F 01	0.897001E 00	0.197791E 01
-64.00	-0.585510F 01	0.118197E 01	0.889041E 00	0.192588E 01
-66.00	-0.578758E 01	0.115051E 01	0.881237F 00	0.187433E 01
-68.00	-0.572189E 01	0.111933F 01	0.873594E 00	0.182326E 01
-70.00	-0.565799E 01	0.108842F 01	0.866113E 00	0.177264E 01
-72.00	-0.559589E 01	0.105777F 01	0.858796F 00	0.172248E 01
-74.00	-0.553556E 01	0.102738E 01	0.851646E 00	0.167276E 01
-76.00	-0.547699E 01	0.997243F 00	0.844666E 00	0.162346E 01
-78.00	-0.542017E 01	0.967348E 00	0.837856E 00	0.157459E 01
-80.00	-0.536508E 01	0.937693F 00	0.831219E 00	0.152613E 01
-82.00	-0.531170E 01	0.908269E 00	0.824756F 00	0.147806E 01
-84.00	-0.526002E 01	0.879072E 00	0.818468E 00	0.143038E 01
-86.00	-0.521004E 01	0.850095E 00	0.812358E 00	0.138307E 01
-88.00	-0.516172E 01	0.821333E 00	0.806425E 00	0.133613E 01
-90.00	-0.511507E 01	0.792778E 00	0.800673E 00	0.128955E 01
-92.00	-0.507006E 01	0.764424E 00	0.795100F 00	0.124330E 01
-94.00	-0.502670F 01	0.736266F 00	0.789710F 00	0.119739E 01
-96.00	-0.498496E 01	0.708295E 00	0.784502E 00	0.115179E 01
-98.00	-0.494484E 01	0.680506E 00	0.779477E 00	0.110650E 01
-100.00	-0.490631E 01	0.652892E 00	0.774637E 00	0.106151E 01
-102.00	-0.486938F 01	0.625447E 00	0.769982E 00	0.101681E 01
-104.00	-0.483404F 01	0.598164E 00	0.765513E 00	0.972380E 00
-106.00	-0.480027E 01	0.571037F 00	0.761230E 00	0.928213E 00
-108.00	-0.476807E 01	0.544060E 00	0.757134F 00	0.884299E 00
-110.00	-0.473742E 01	0.517223E 00	0.753226F 00	0.840624E 00
-112.00	-0.470832E 01	0.490523E 00	0.749506E 00	0.797179E 00
-114.00	-0.468076E 01	0.463951F 00	0.745974E 00	0.753950E 00
-116.00	-0.465473E 01	0.437502F 00	0.742631E 00	0.710928E 00
-118.00	-0.463022E 01	0.411168F 00	0.739477E 00	0.668101E 00
-120.00	-0.460724E 01	0.384942E 00	0.736514E 00	0.625456E 00
-122.00	-0.458577E 01	0.358819E 00	0.733740E 00	0.582984E 00

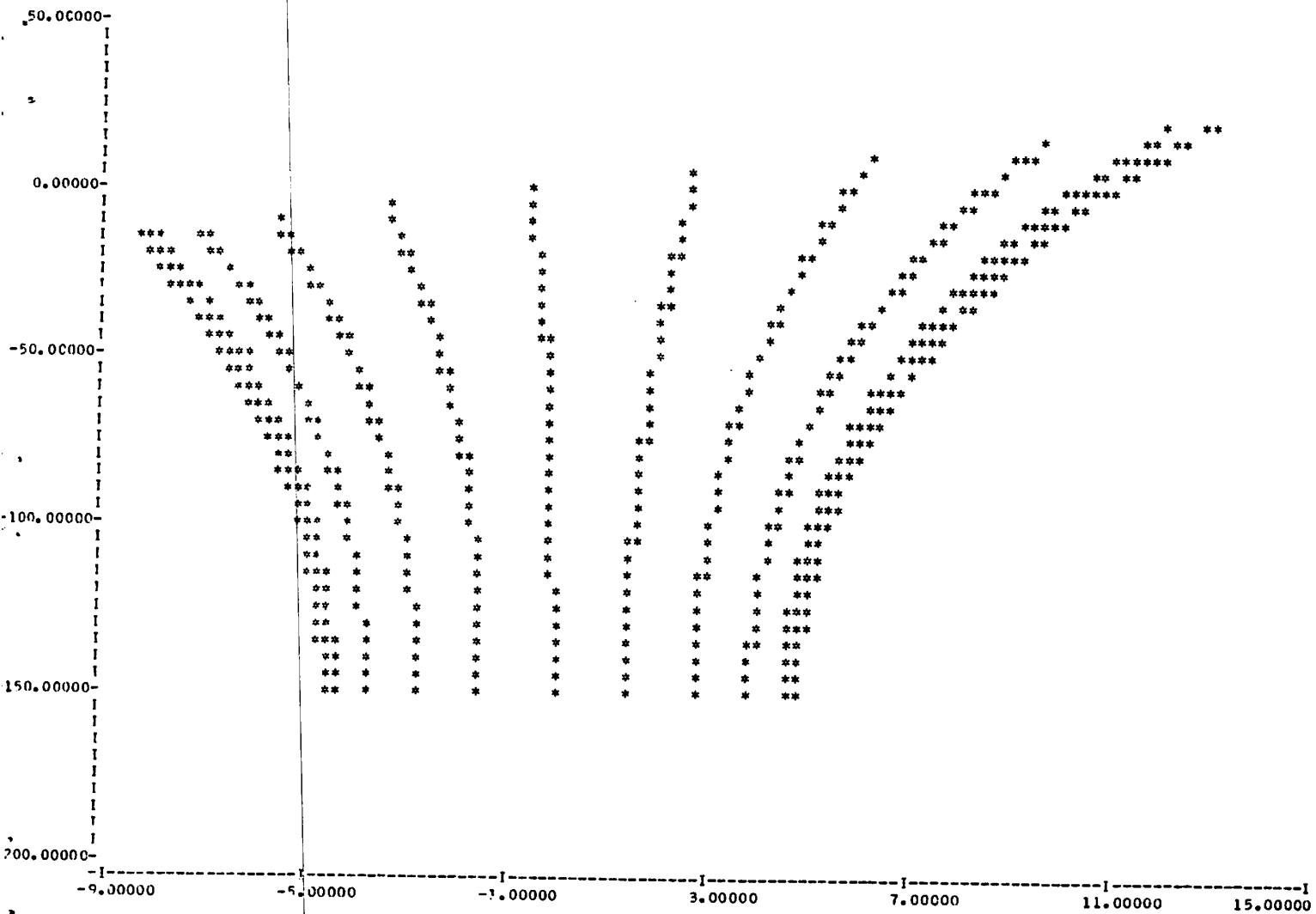
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-128.00	-0.453037E 01	0.280993E 00	0.726560E 00	0.456483E 00
-130.00	-0.451490E 01	0.255209E 00	0.724549E 00	0.414584E 00
-132.00	-0.450091E 01	0.229494E 00	0.722728E 00	0.372799E 00
-134.00	-0.448840E 01	0.203841E 00	0.721099E 00	0.331117E 00
-136.00	-0.447737E 01	0.178241E 00	0.719660E 00	0.289526E 00
-138.00	-0.446782E 01	0.152690E 00	0.718414E 00	0.248017E 00
-140.00	-0.445974E 01	0.127179E 00	0.717360E 00	0.206575E 00
-142.00	-0.445314E 01	0.101702E 00	0.716496E 00	0.165191E 00
-144.00	-0.444800E 01	0.762528E-01	0.715825E 00	0.123853E 00
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-148.00	-0.444213E 01	0.254085E-01	0.715057E 00	0.412693E-01
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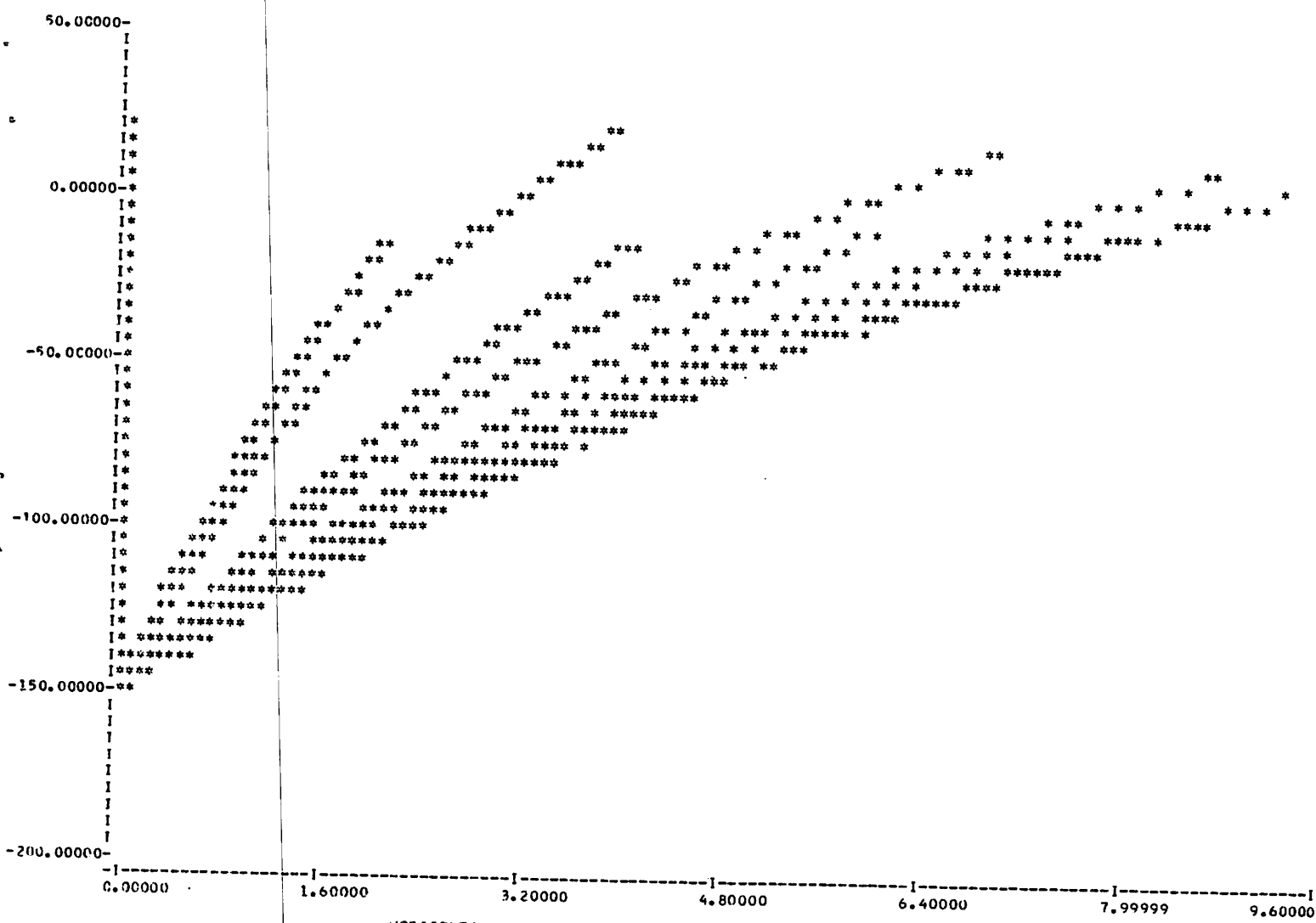
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-16.00	-0.840621E 01	0.165320E-04	0.898722E-05	0.341441E 01
-18.00	-0.828604E 01	0.162140E-04	0.890860E-05	0.334873E 01
-20.00	-0.816820E 01	0.158989E-04	0.882993E-05	0.328364E 01
-22.00	-0.805266E 01	0.155865E-04	0.875130E-05	0.321912E 01
-24.00	-0.793940E 01	0.152769E-04	0.867280E-05	0.315518E 01
-26.00	-0.782840E 01	0.149701E-04	0.859451E-05	0.309181E 01
-28.00	-0.771964E 01	0.146660E-04	0.851652E-05	0.302902E 01
-30.00	-0.761311E 01	0.143648E-04	0.843891E-05	0.296680E 01
-32.00	-0.750878E 01	0.140663E-04	0.836173E-05	0.290514E 01
-34.00	-0.740662E 01	0.137705E-04	0.828506E-05	0.284405E 01
-36.00	-0.730663E 01	0.134774E-04	0.820896E-05	0.278352E 01
-38.00	-0.720879E 01	0.131870E-04	0.813350E-05	0.272355E 01
-40.00	-0.711306E 01	0.128993E-04	0.805872E-05	0.266413E 01
-42.00	-0.701943E 01	0.126143E-04	0.798469E-05	0.260526E 01
-44.00	-0.692788E 01	0.123318E-04	0.791145E-05	0.254692E 01
-46.00	-0.683840E 01	0.120520E-04	0.783906E-05	0.248912E 01
-48.00	-0.675097E 01	0.117747E-04	0.776756E-05	0.243185E 01
-50.00	-0.666556E 01	0.114999E-04	0.769699E-05	0.237510E 01
-52.00	-0.658216E 01	0.112276E-04	0.762739E-05	0.231886E 01
-54.00	-0.650075E 01	0.109578E-04	0.755880E-05	0.226314E 01
-56.00	-0.642130E 01	0.106904E-04	0.749125E-05	0.220791E 01
-58.00	-0.634381E 01	0.104253E-04	0.742479E-05	0.215317E 01
-60.00	-0.626826E 01	0.101626E-04	0.735944E-05	0.209892E 01
-62.00	-0.619463E 01	0.990225E-05	0.729523E-05	0.204514E 01
-64.00	-0.612290E 01	0.964412E-05	0.723219E-05	0.199183E 01
-66.00	-0.605306E 01	0.938823E-05	0.717034E-05	0.193898E 01
-68.00	-0.598509E 01	0.913449E-05	0.710972E-05	0.188657E 01
-70.00	-0.591897E 01	0.888290E-05	0.705035E-05	0.183461E 01
-72.00	-0.585468E 01	0.863338E-05	0.699223E-05	0.178308E 01
-74.00	-0.579223E 01	0.838592E-05	0.693541E-05	0.173197E 01
-76.00	-0.573159E 01	0.814044E-05	0.687989E-05	0.168127E 01
-78.00	-0.567273E 01	0.789693E-05	0.682570E-05	0.163098E 01
-80.00	-0.561566E 01	0.765531E-05	0.677285E-05	0.158107E 01
-82.00	-0.556036E 01	0.741554E-05	0.672136E-05	0.153156E 01
-84.00	-0.550680E 01	0.717758E-05	0.667124E-05	0.148241E 01
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-88.00	-0.540490E 01	0.670688E-05	0.657518E-05	0.138519E 01
-90.00	-0.535654E 01	0.647404E-05	0.652926E-05	0.133710E 01
-92.00	-0.530987E 01	0.624280E-05	0.648475E-05	0.128935E 01
-94.00	-0.526490E 01	0.601313E-05	0.644169E-05	0.124191E 01
-96.00	-0.522161E 01	0.578495E-05	0.640006E-05	0.119479E 01
-98.00	-0.517998E 01	0.555824E-05	0.635989E-05	0.114796E 01
-100.00	-0.514001E 01	0.533292E-05	0.632118E-05	0.110142E 01
-102.00	-0.510169E 01	0.510895E-05	0.628393E-05	0.105517E 01
-104.00	-0.506501E 01	0.488628E-05	0.624816E-05	0.100918E 01
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-108.00	-0.499654E 01	0.444463E-05	0.618108E-05	0.917962E 00
-110.00	-0.496472E 01	0.422553E-05	0.614976E-05	0.872712E 00
-112.00	-0.493450E 01	0.400752E-05	0.611996E-05	0.827686E 00
-114.00	-0.490589E 01	0.379054E-05	0.609165E-05	0.782874E 00
-116.00	-0.487886E 01	0.357455E-05	0.606486E-05	0.738263E 00
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-120.00	-0.482954E 01	0.314528E-05	0.601580E-05	0.649605E 00
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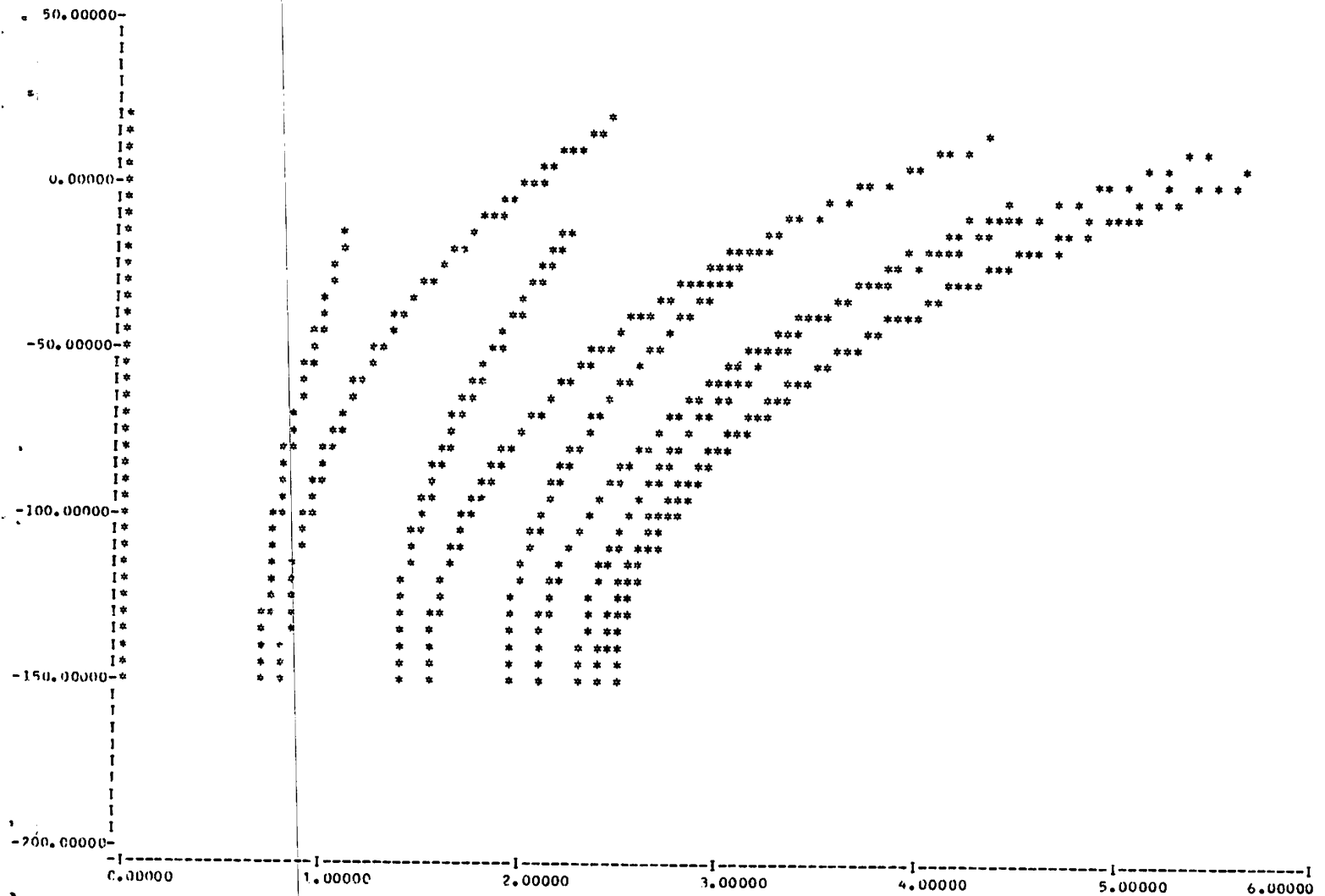
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-128.00	-0.474970E 01	0.229612E-05	0.593594E-05	0.474225E 00
-130.00	-0.473362E 01	0.208547E-05	0.591980E-05	0.430718E 00
-132.00	-0.471908E 01	0.187536E-05	0.590518E-05	0.387324E 00
-134.00	-0.470609E 01	0.166575E-05	0.589210E-05	0.344032E 00
-136.00	-0.469463E 01	0.145657E-05	0.588055E-05	0.300830E 00
-138.00	-0.468471E 01	0.124778E-05	0.587055E-05	0.257707E 00
-140.00	-0.467632E 01	0.103931E-05	0.586208E-05	0.214652E 00
-142.00	-0.466945E 01	0.831122E-06	0.585515E-05	0.171654E 00
-144.00	-0.466411E 01	0.623150E-06	0.584976E-05	0.128701E 00
-146.00	-0.466031E 01	0.415342E-06	0.584591E-05	0.857819E-01
-148.00	-0.465802E 01	0.207644E-06	0.584359E-05	0.428853E-01
-150.00	-0.465726E 01	0.000000E 00	0.584283E-05	-0.000000E 00



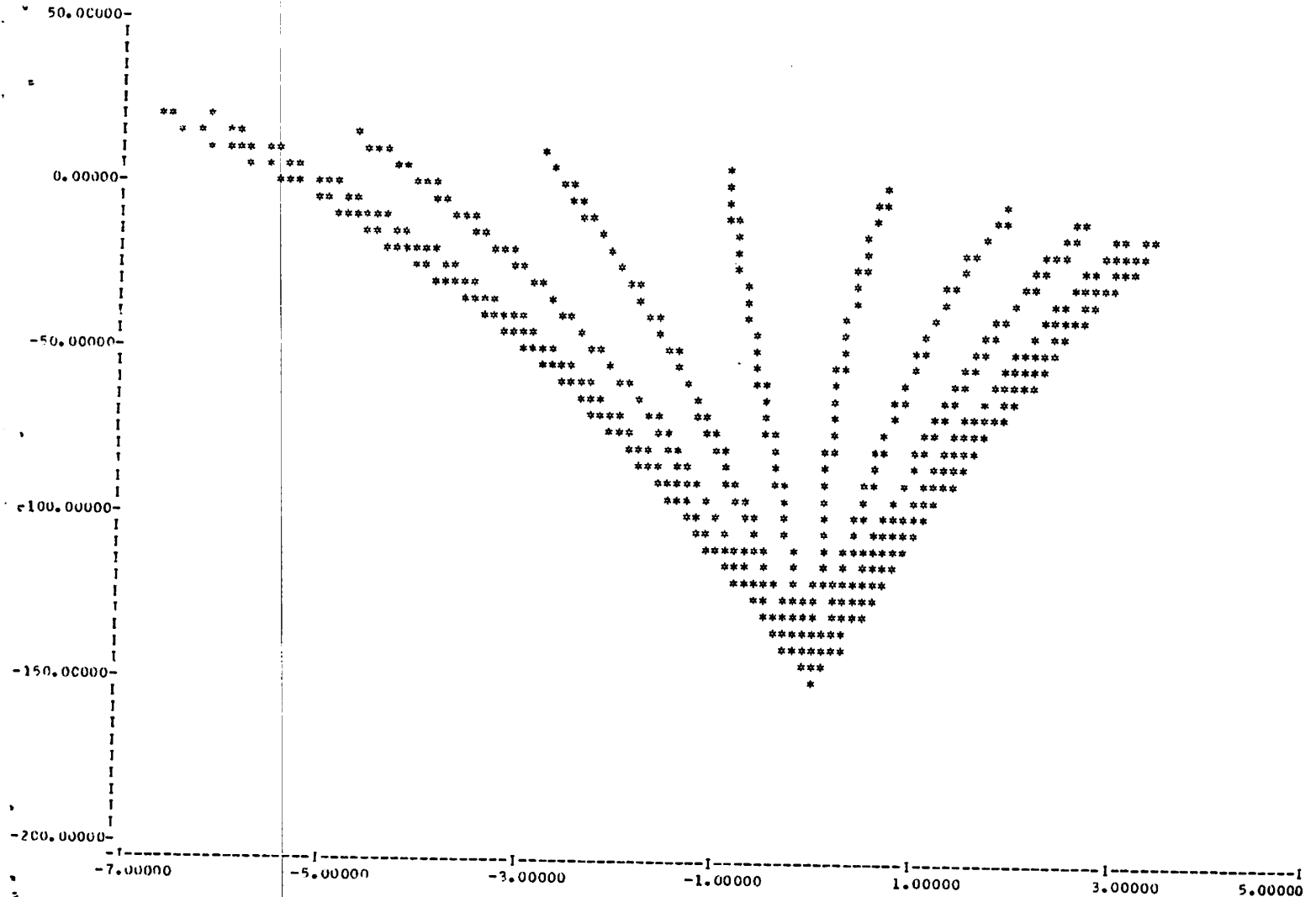
HORIZONTAL AXIS - HORIZ. VELOCITIES  
 VERTICAL AXIS - DEPTH  
 HORIZ. VELOCITIES  
 VERSUS DEPTH



HORIZONTAL AXIS - VERTICAL VELOCITIES  
 VERTICAL AXIS - DEPTH  
 VERTICAL VELOCITIES  
 VERSUS DEPTH



HORIZONTAL AXIS - HORIZ. ACCELERATIONS  
 VERTICAL AXIS - DEPTH  
 HORIZ. ACCELERATIONS  
 VERSUS DEPTH



HORIZONTAL AXIS - VERT. ACCELERATIONS  
 VERTICAL AXIS - DEPTH  
 VERT. ACCELERATIONS  
 VERSUS DEPTH

### III. CNOIDAL WAVE THEORY

#### 1. General Comment

This program calculates values describing water particle motion using cnoidal wave theory. This wave theory is applicable over a range of  $1/50 \leq d/L < 1/10$ .

To use the cnoidal wave theory it is necessary to compute the complete elliptic integral of the first kind,  $K(k)$ , the complete elliptic integral of the second kind,  $E(k)$ , and the Jacobian elliptic functions  $sn$ ,  $cn$ , and  $dn$ . This program generates all of these values.

Values of water particle velocity and acceleration are calculated for given depth increments at different positions along a wave.

This program has no limitations, however, this wave theory should just be used over a range of  $d/L$  values specified above, otherwise the derived values may be erroneous. An iterative process is used to solve for the wavelength and the wave period.

Characteristics of the wave which are needed for this program are wave height, water depth, and either wavelength or wave period.

#### 2. Program Description

##### Main Program

Purpose: Using Cnoidal Wave theory the following values are calculated:

1. Wave length or wave period.
2. Wave velocity.
3. Water particle velocities at varying depths and at equally spaced cross-sections along the wave.
4. Water particle accelerations at varying depths and at equally spaced cross-sections along the wave.

These values are calculated from the upper limit of  $d/L$  of  $1/10$  where modulus  $k \rightarrow 0$  to where  $k$  is approximately  $0.95$ . For  $k$  values higher (approaching Solitary wave theory) the Subroutine SOLVEK is used.

Equations: For the generation of the complete elliptic integral of the first kind,  $K(k)$ , and the complete elliptic integral of the second kind,  $E(k)$ , the following series were used:

$$K(k) = \frac{\pi}{2} \left[ 1 + \left(\frac{1}{2}\right)^2 k^2 + \left(\frac{3}{2 \cdot 4}\right)^2 k^4 + \left(\frac{3 \cdot 5}{2 \cdot 4 \cdot 6}\right)^2 k^6 + \dots \right]$$

$$E(k) = \frac{\pi}{2} \left[ 1 - \left(\frac{1}{2}\right)^2 k^2 - \left(\frac{3^2}{2^2 \cdot 4^2}\right) \frac{k^4}{3} - \left(\frac{3^2 \cdot 5^2}{2^2 \cdot 4^2 \cdot 6^2}\right) \frac{k^6}{5} \right. \\ \left. - \left(\frac{3^2 \cdot 5^2 \cdot 7^2}{2^2 \cdot 4^2 \cdot 6^2 \cdot 8^2}\right) \frac{k^8}{7} \dots \right]$$

$$K(k') = \frac{\pi}{2} \left[ 1 + \left(\frac{1}{2}\right)^2 k'^2 + \left(\frac{3}{2 \cdot 4}\right)^2 k'^4 + \left(\frac{3 \cdot 5}{2 \cdot 4 \cdot 6}\right)^2 k'^6 + \dots \right]$$

where

$$k' = \sqrt{1 - k^2}$$

Now several of the wave characteristics may be calculated.

$$L = \frac{16d^3}{3H} \cdot k \cdot K(k)$$

$$Y_c = \frac{16d^3}{3L^2} \left\{ K(k) [K(k) - E(k)] \right\} + d$$

$$Y_t = Y_c - H$$

$$C = \sqrt{gy_t} \left[ 1 + \frac{H}{Y_t} \frac{1}{k^2} \frac{1}{2} - \frac{E(k)}{K(k)} \right]$$

$$T = \frac{L}{C}$$

To compute the wave profile, the Jacobian elliptic function  $cn$  is generated from the following series:

$$cn(u) = \frac{2\pi}{k K(k)} \sum_{s=0}^{s=\infty} \frac{Q^{s + \frac{1}{2}}}{1 + Q^{2s+1}} \cos \left[ \frac{(2s + 1)(\pi u)}{2k} \right]$$

where

$$u = 2K(k) \left( \frac{x}{L} - \frac{t}{T} \right)$$

The other Jacobian elliptic functions can now be calculated.

$$sn^2(u) = 1 - cn^2(u)$$

$$dn^2(u) = 1 - k^2 sn^2(u)$$

When  $k \rightarrow 1$  their values can be approximated by the following expressions

$$sn(u) = \tanh(u) + \frac{(k')^2}{4} \operatorname{sech}^2(u) [\sinh(u)\cosh(u) - u]$$

$$cn(u) = \operatorname{sech}(u) - \frac{(k')^2}{4} \tanh(u)\operatorname{sech}(u) \cdot [\sinh(u)\cosh(u) - u]$$

$$dn(u) = \operatorname{sech}(u) + \frac{(k')^2}{4} \tanh(u)\operatorname{sech}(u) [\sinh(u)\cosh(u) + u]$$

The wave profile can now be computed

$$y_s = y_t + H cn^2(u)$$

Horizontal velocity

$$u = \sqrt{gd} \left\{ -\frac{5}{4} + \frac{3y_t}{2d} - \frac{y_t^2}{4d^2} + \left( \frac{3H}{2d} - \frac{y_t H}{2d^2} \right) cn^2(u) - \frac{H^2}{4d^2} cn^4(u) - \frac{8HK(k)}{L^2} \left( \frac{d}{3} - \frac{y_t^2}{2d} \right) \right. \\ \left. [-k^2 sn^2(u)cn^2(u) + cn^2(u)dn^2(u) - sn^2(u)dn^2(u)] \right\}$$

Vertical velocity

$$v = \sqrt{gd} \left\{ y \frac{2HK(k)}{Ld} \left[ 1 + \frac{y_t}{d} + \frac{H}{d} cn^2(u) + \frac{32K(k)^2}{3L^2} \left( d^2 - \frac{y_t^2}{2} \right) (k^2 sn^2(u) - k^2 cn^2(u) - dn^2(u)) \right] sn(u) cn(u) dn(u) \right\}$$



## Horizontal acceleration

$$\begin{aligned} \frac{\partial U}{\partial t} = & \sqrt{gd} \frac{4HK(k)}{Td} \left[ \left( \frac{3}{2} - \frac{\gamma t}{2d} \right) - \frac{H}{2d} \text{cn}^2(u) \right. \\ & + \frac{16K(k)^2}{L^2} \left( \frac{d^2}{3} - \gamma^2 \right) (k^2 \text{sn}^2(u) \\ & \left. - k^2 \text{cn}^2(u) - \text{dn}^2(u)) \right] \text{sn}(u) \text{dn}(u) \text{cn}(u) \end{aligned}$$

## Vertical acceleration

$$\begin{aligned} \frac{\partial V}{\partial t} = & \gamma \sqrt{gd} \frac{4HK(k)^2}{LTd} \left\{ \left( 1 + \frac{\gamma t}{d} \right) [\text{sn}^2(u) \text{dn}^2(u) \right. \\ & \left. - \text{cn}^2(u) \text{dn}^2(u) + k^2 \text{sn}^2(u) \text{cn}^2(u)] \right. \\ & + \frac{H}{d} [3\text{sn}^2(u) \text{dn}^2(u) - \text{cn}^2(u) \text{dn}^2(u) \\ & + k^2 \text{sn}^2(u)] \text{cn}^2(u) - \frac{32K(k)^2}{3L^2} \left( d^2 - \frac{\gamma^2}{2} \right) \\ & \cdot [9k^2 \text{sn}^2(u) \text{cn}^2(u) \text{dn}^2(u) - k^2 \text{sn}^4(u) \\ & \cdot (k^2 \text{cn}^2(u) + \text{dn}^2(u)) + k^2 \text{cn}^4(u)(k^2 \text{sn}^2(u) \\ & \left. + \text{dn}^2(u)) + \text{dn}^4(u)] \right\} \end{aligned}$$

Subroutine Solvek

Purpose: To solve for values of the modulus,  $k$ ,  $K(k)$ ,  $E(k)$ , and wavelength,  $L$ , or wave period,  $T$ , when  $k \rightarrow 1$ .

Equations:

$$K(k) = G + \frac{G-1}{4} k'^2 + \frac{9}{64} \left( G - \frac{7}{6} \right) k'^4 + \frac{25}{256} \left( G - \frac{37}{30} \right) k'^6 + \dots$$

$$E(k) = 1 + \frac{1}{2} \left( G - \frac{1}{2} \right) k'^2 + \frac{3}{16} \left( G - \frac{13}{12} \right) k'^4 + \frac{15}{128} \left( G - \frac{6}{5} \right) k'^6 + \dots$$

where

$$G = \ln\left(\frac{4}{k'}\right)$$

## 6. Notation

Symbol	FORTRAN Name	Description
$a_x$	AX	water particle acceleration in the horizontal direction
$a_y$	AY	water particle acceleration in the vertical direction
C	CEL	wave speed
cn	CN1	Jacobian elliptic function
d	D	water depth
dn	DN1	Jacobian elliptic function
$E(k)$	EIE	complete elliptic integral of the second kind
H	H	wave height
k	TK	elliptic modulus
$k'$	TKP	complementary elliptic modulus
$K(k)$	EIK	complete elliptic integral of the first kind
$K(k)'$	EIKP	complementary complete elliptic integral of the first kind
L	WL	wavelength
sn	SN1	Jacobian elliptic integral
T	T	wave period
u	U	water particle velocity in the horizontal direction
v	V	water particle velocity in the vertical direction
$Y_c$	YC	height of wave crest above bottom
$Y_t$	YT	height of wave trough above bottom

## 4. Bibliography

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2. Jahnke, Eugene and Fritzy Emde, Tables of Functions with Formulas and Curves, 4th ed., New York, Dover Publications, Inc., 1945.
3. Milne-Thomson, L. M., Jacobian Elliptic Function Tables, New York, Cover Publications, Inc., 1950.
4. Selby, Samuel M., ed., Standard Mathematical Tables, Cleveland, The Chemical Rubber Co., 1965.
5. Wiegel, Robert L., Oceanographical Engineering, Englewood Cliffs, Prentice-Hall, Inc., 1964.

C  
 C CNOIDAL WAVE THEORY  
 C  
 C IF WAVELENGTH, WAVE HEIGHT, AND DEPTH ARE GIVEN, NUM=1  
 C IF WAVE PERIOD, WAVE HEIGHT, AND DEPTH ARE GIVEN, NUM=2  
 C NPRINT, X, XT, WLSAVE, T, EIK, EIE, SYMBOL, XK, TKPS=0  
 C T=WAVE PERIOD  
 C H=WAVE HEIGHT  
 C D=WATER DEPTH  
 C DEPINC=DEPTH INCREMENTATION DESIRED (SHOULD BE AN INTEGER)  
 C XHEAD, YHEAD, AND TITLE ARE THE HEADINGS OF THE X-AXIS, Y-AXIS, AND  
 C TITLE OF EACH GRAPH  
 C WL=WAVELENGTH  
 C CEL=WAVE SPEED  
 C YC=HEIGHT OF WAVE CREST FROM BOTTOM  
 C YT=HEIGHT OF WAVE TROUGH FROM BOTTOM  
 C XDL=DISTANCE ALONG WAVE IN LENGTH  
 C TDT=DISTANCE ALONG WAVE IN TIME  
 C U=HORIZONTAL VELOCITY OF A PARTICLE AT DISTANCE Y FROM THE BOTTOM  
 C V=VERTICAL VELOCITY OF A PARTICLE AT DISTANCE Y FROM THE BOTTOM  
 C AX=HORIZONTAL ACCELERATION OF A PARTICLE AT DISTANCE Y FROM THE  
 C BOTTOM  
 C AZ=VERTICAL ACCELERATION OF A PARTICLE AT DISTANCE Y FROM THE  
 C BOTTOM  
 C K=ELLIPTIC MODULUS  
 C K(K)=COMPLETE ELLIPTIC INTEGRAL OF THE FIRST KIND  
 C E(K)=COMPLETE ELLIPTIC INTEGRAL OF THE SECOND KIND  
 C SN, CN, AND DN=JACOBIAN ELLIPTIC FUNCTIONS  
 C

1 DIMENSION UP(999), VP(999), AXP(999), AZP(999), YSP(50), XHEAD(5), YHEAD  
 1(5), TITLE(10), XHEADA(5), XHEADB(5), XHEADC(5), XHEADD(5), YHEADA(5), YH  
 2EADB(5), YHEADC(5), YHEADD(5), TITLEA(10), TITLEB(10), TITLEC(10), TITLE  
 3D(10), YP(999), XDLP(50), NAME(20,20)  
 2 READ(5,101)(XHEAD(I), I=1,5)  
 3 READ(5,101)(XHEADA(I), I=1,5)  
 4 READ(5,101)(XHEADB(I), I=1,5)  
 5 READ(5,101)(XHEADC(I), I=1,5)  
 6 READ(5,101)(XHEADD(I), I=1,5)  
 7 READ(5,101)(YHEAD(I), I=1,5)  
 8 READ(5,101)(YHEADA(I), I=1,5)  
 9 READ(5,101)(YHEADB(I), I=1,5)  
 10 READ(5,101)(YHEADC(I), I=1,5)  
 11 READ(5,101)(YHEADD(I), I=1,5)  
 12 READ(5,101)(TITLE(I), I=1,10)  
 13 READ(5,101)(TITLEA(I), I=1,10)  
 14 READ(5,101)(TITLEB(I), I=1,10)  
 15 READ(5,101)(TITLEC(I), I=1,10)  
 16 READ(5,101)(TITLED(I), I=1,10)  
 17 READ(5,99) NUM, NPRINT, X, XT, WLSAVE, T, EIK, EIE, SYMBOL, XK, TKPS  
 18 IF (NUM.EQ.1) READ(5,100) WL, H, D, DEPINC  
 19 IF (NUM.EQ.2) READ(5,100) T, H, D, DEPINC  
 20 IF (NUM.EQ.1) GO TO 1  
 21 WL = 8.0\*SQRT(D\*D\*D/H)  
 22 1 SAVE=0.0  
 23 TK=1.0  
 24 G=32.2  
 25 PI=3.1416  
 26 C=WL\*\*2.\*H/D\*\*3.  
 27 5 SUM=0.0  
 28 A=1.0

```

29      DO 10 N=1,99,2
30      IF(A.LT..01E-35)GO TO 11
31      O=N
32      EIK=((O/(O+1))**2)*(TK**2)*A
33      SUM=SUM+EIK
34      10 A=EIK
35      11 EIK=(PI/2.)*(1.+SUM)
36      DIFF=C-((16./3.)*(TK**2)*(EIK**2))
37      IF(ABS(DIFF).LT.0.001)GO TO 20
38      15 IF(DIFF)16,20,17
39      16 X=TK
40      TK=(TK+SAVE)/2.
41      GO TO 5
42      17 SAVE=TK
43      IF(X.EQ.0.0)CALL SOLVEK(NUM,WL,H,D,WLSAVE,T,EIK,EIE,TKPS,XK,YC,YT,
1CEL,WL,XT,TK)
44      IF(X.EQ.0.0)GO TO 180
45      TK=(X+TK)/2.
46      GO TO 5
47      20 SUM=0.0
48      A=1.0
49      DO 30 N=2,98,2
50      IF(A.LT..01E-35)GO TO 31
51      O=N
52      EIE=((O-1)/O)**2.*TK*TK*A/(O-1)
53      SUM=SUM-EIE
54      30 A=EIE*(O-1)
55      31 EIE=(PI/2.)*(1.+SUM)
56      YC=((16./((3.*C)))*H*(EIK*(EIK-EIE))) +D
57      YT=YC-H
58      CEL=(SQRT(G*YT))*(1+((H/(YT*(TK*TK)))*1.5-(EIE/EIK))))
59      IF(NUM.EQ.1)GO TO 180
60      TT=WL/CEL
61      TDIFF=T-TT
62      IF(ABS(TDIFF).LT.0.01) GO TO 190
63      IF(TDIFF)18,190,19
64      18 XT=WL
65      WL=(WL+WLSAVE)/2.
66      GO TO 1
67      19 WLSAVE=WL
68      IF(XT.EQ.0.0)CALL SOLVEK(NUM,T,H,D,WLSAVE,T,EIK,EIE,TKPS,XK,YC,YT
1,CEL,WL,XT,TK)
69      IF(XK.GT.0.0)GO TO 190
70      WL=(WL+XT)/2.
71      GO TO 1
72      180 T=WL/CEL
73      190 TK2=TK*TK
74      WRITE(6,200) WL,H,D,YC,YT,CEL,T,TK2,EIK,EIE
75      IF(XK.GT.0.0)GO TO 55
76      A=1.0
77      SUM=0.0
78      TKP=SQRT(1.-TK**2.)
79      DO 50 N=1,99,2
80      IF(A.LT..01E-35)GO TO 51
81      O=N
82      EIKP=((O/(O+1))**2)*(TKP**2)*A
83      SUM=SUM+EIKP
84      50 A=EIKP
85      51 EIKP=(PI/2.)*(1.+SUM)
86      Q=2.718282**(-PI*EIKP/EIK)
87      55 XDL=0.0

```

```

88     TDT=0.0
89     L=0
90     DO 70 MM=1,11
91     IF(XK.GT.0.0)GO TO 65
92     SUM=0.0
93     DO 60 N=1,20
94     S=N-1
95     THETA=(2.*S+1.)*PI*(XDL-TDT)
96     CN1=(Q**(S+.5))*COS(THETA)/(1.+(Q**(2.*S+1.)))
97     IF(CN1.LT..1E-35)GO TO 61
98     60 SUM=SUM+CN1
99     61 CN1=(2.*PI/(TK*EIK))*SUM
100    CN2=CN1*CN1
101    SN2=1.-CN2
102    DN2=1.-TK*TK*SN2
103    GO TO 66
104    65 XU=2.*EIK*(XDL-TDT)
105    SN2=(TANH(XU)+.25*TKPS/COSH(XU)**2.*(SINH(XU)*COSH(XU)-XU)**2.
106    CN2=(1./COSH(XU)-.25*TKPS*TANH(XU)/COSH(XU)*(SINH(XU)*COSH(XU)-XU
107    DN2=(1./COSH(XU)+.25*TKPS*TANH(XU)/COSH(XU)*(SINH(XU)*COSH(XU)+XU
108    66 IF(SN2.LT..1E-20)SN2=0.0
109    IF(CN2.LT..1E-20)CN2=0.0
110    IF(DN2.LT..1E-20)DN2=0.0
111    YS=H*CN2+YT
112    YSP(MM)=YS
113    CU=SQRT(G*D)
114    CU1=(-1.25)+(1.5*YT/D)-(.25*YT*YT/(D*D))+((1.5*H/D)-(.5*YT*H/(D*
115    D))*CN2)-(.25*H*H*CN2*CN2/(D*D))
116    CU2=-8.*H*EIK*EIK/(WL*WL)
117    CU3=(-TK2*SN2*CN2)+(CN2*DN2)-(SN2*DN2)
118    CV=(SQRT(G*D*SN2*CN2*DN2))*2.*H*EIK/(WL*D)
119    CV1=1.+(YT/D)+(H*CN2/D)
120    CV2=(32.*EIK*EIK/(3.*WL*WL))*((TK2*SN2)-(TK2*CN2)-DN2)
121    CAX=(SQRT(G*D*SN2*CN2*DN2))*4.*H*EIK/(T*D)
122    CAX1=(1.-(.5*YT/D))-(.5*H*CN2/D)
123    CAX2=(16.*EIK*EIK/(WL*WL))*((TK2*SN2)-(TK2*CN2)-DN2)
124    CAZ=(SQRT(G*D))*4.*H*EIK*EIK/(WL*T*D)
125    CAZ1=(1.+(YT/D))*((SN2*DN2)-(CN2*DN2)+(TK2*SN2*CN2))
126    CAZ2=H*CN2*((3.*SN2*DN2)-(CN2*DN2)+(TK2*SN2))/D
127    CAZ3=(-32.*EIK*EIK/(3.*WL*WL))*((9.*TK2*SN2*CN2*DN2)-((TK2*SN2*SN2
128    1)-(TK2*CN2)+DN2))+((TK2*CN2*CN2)*((TK2*SN2)+DN2))+((DN2*DN2)*(SN2
129    1-CN2)))
127    WRITE(6,300)XDL
128    YI=YS/DEPINC
129    I=YI+2
130    M=I-1
131    DO 40 N=1,I
132    K=N-1
133    Y=DEPINC*(M-K)
134    IF(K.EQ.0)Y=YS
135    U=CU*(CU1+(CU2*CU3*((D/3.)-(1.-.5*Y*Y/D))))
136    V=(CV*Y)*(CV1+(CV2*((D*D)-(1.-.5*Y*Y))))
137    AX=CAX*(CAX1+(CAX2*((D*D/3.)-(1.-Y*Y)))
138    AZ=(Y*CAZ)*(CAZ1+CAZ2+(CAZ3*((D*D)-(1.-.5*Y*Y))))
139    L=L+1
140    UP(L)=U
141    VP(L)=V
142    AXP(L)=AX
143    AZP(L)=AZ

```

```

144     YP(L)=Y
145 40 WRITE(6,400)Y,U,V,AX,AZ
146     XDLP(MM)=XDL
147 70 XDL=XDL+0.05
148     NM=11
149     CALL GRAPH(UP,YP,L,SYMBOL,XHEAD,YHEAD,TITLE,NPRINT)
150     CALL GRAPH(VP,YP,L,SYMBOL,XHEADA,YHEADA,TITLEA,NPRINT)
151     CALL GRAPH(AXP,YP,L,SYMBOL,XHEADB,YHEADB,TITLEB,NPRINT)
152     CALL GRAPH(AZP,YP,L,SYMBOL,XHEADC,YHEADC,TITLEC,NPRINT)
153     CALL GRAPH(XDLP,YSP,NM,SYMBOL,XHEADD,YHEADD,TITLED,NPRINT)
154 99 FORMAT(2I1,20F2.1)
155 100 FORMAT(8F10.4)
156 101 FORMAT(10A4)
157 200 FORMAT(1H1,////////,T45,'VALUES DERIVED USING CNOIDAL WAVE THEORY',
1////////,T50,'WAVE LENGTH   =',F10.3,///,T50,'WAVE HEIGHT   =',
2F10.3,///,T50,'WATER DEPTH  =',F10.3,///,T50,'YC              =',
3F10.3,///,T50,'YT              =',F10.3,///,T50,'WAVE CELERITY =',
4F10.3,///,T50,'WAVE PERIOD   =',F10.3,///,T50,'K**2          =',
5F10.3,///,T50,'K(K)         =',F10.3,///,T50,'E(K)           =',
6F10.3)
158 300 FORMAT(1H1,T60,'X/L =',F4.2,3(//),T36,'Y',T44,'HORIZONTAL',T60,'VER
1TICAL',T76,'HORIZONTAL',T93,'VERTICAL',/,T45,'VELOCITY',T60,'VELOC
2ITY',T75,'ACCELERATION',T91,'ACCELERATION',/)
159 400 FORMAT(T26,F13.2,4E16.6)
160     STOP
161     END

162     SUBROUTINE SOLVEK(NUM,DUM,H,D,WLSAVE,T,EIK,EIE,TKPS,XK,YC,YT,CEL,
1WL,XT,TK)
163     XK=1.0
164     IF(NUM.EQ.1)WL=DUM
165     IF(NUM.EQ.2)T=DUM
166     IF(NUM.EQ.1)GO TO 1
167     WL =200.*SQRT(D*D*D/H)
168 1 SAVE=.1E-75
169     X=.2
170     PI=3.1416
171     C=WL*WL*H/(D*D*D)
172     TK2=1.0
173     TKPS = .199
174 5 TKP=SQRT(TKPS)
175     G=ALOG(4./TKP)
176     EIK=G+(G-1.)*TKPS/4.
177     IF(TKPS.LT..1E-36)GO TO 10
178     EIK=EIK+(G-7./6.)*9.*TKPS*TKPS/64.
179     IF(TKPS.LT..1E-24)GO TO 10
180     EIK=EIK+(G-37./30.)*25.*TKPS*TKPS*TKPS/256.
181 10 TK2=1.-TKPS
182     DIFF=C-16.*TK2*EIK*EIK/3.
183     IF(ABS(DIFF).LT..1)GO TO 25
184     IF(DIFF)15,25,20
185 15 SAVE=TKPS
186     TKPS=10.**((ALOG10(TKPS)+ALOG10(X))/2.)
187     GO TO 5
188 20 X=TKPS
189     TKPS=10.**((ALOG10(TKPS)+ALOG10(SAVE))/2.)
190     GO TO 5
191 25 EIE=1.+5*(G-.5)*TKPS
192     IF(TKPS.LT..1E-36)GO TO 30
193     EIE=EIE+3./16.*(G-13./12.)*TKPS*TKPS
194     IF(TKPS.LT..1E-24)GO TO 30

```





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254     NSIG=(SIGY+4.500)/5.0
255     YRANGE=NSIG*5
256     YRANGE=YRANGE*(SCALE**(N+1)/SCALE)
257     YTOP=YBOT+YRANGE
258 200 CONTINUE
259     IF(NPRINT.EQ.2.OR.NPRINT.EQ.3) GO TO 160
260     DO 20 M=2,122
261     DO 30 K=1,51
262     PLOT(M,K)=BLANK
263 30 CONTINUE
264 20 CONTINUE
265     DO 40 M=1,51
266     PLOT(1,M)=YAXIS
267 40 CONTINUE
268     DO 50 M=1,122
269     PLOT(M,52)=XAXIS
270 50 CONTINUE
271     DO 100 L=2,122,20
272     PLOT(L,52)=YAXIS
273 100 CONTINUE
274     DO 110 L=1,51,10
275     PLOT(1,L)=XAXIS
276 110 CONTINUE
277     XSCALE(1)=XBOT
278     XSCALE(7)=XTOP
279     DO 120 L=2,6
280     X=L-1
281     XSCALE(L)=XBOT+X*XRANGE/6.0
282 120 CONTINUE
283     YSCALE(6)=YBOT
284     DO 130 L=1,5
285     X=6-L
286     YSCALE(L)=YBOT+X*YRANGE/5.0
287 130 CONTINUE
288 160 CONTINUE
289     DO 60 J=1,I
290     SYM=SYMBOL
291     X1=DATA(X(J))-XBOT
292     X2=X1/XRANGE
293     JX=X2*120.0+2.5
294     IF(JX.LT.2) GO TO 900
295     IF(JX.GT.122) GO TO 901
296 70 Y1=DATA(Y(J))-YBOT
297     Y2=Y1/YRANGE
298     JY=51.5-(Y2*50.0)
299     IF(JY.LT.1) GO TO 903
300     IF(JY.GT.51) GO TO 902
301 80 PLOT(JX,JY)=SYM
302     GO TO 60
303 900 JX=2
304     SYM=POINT
305     GO TO 70
306 901 JX=122
307     SYM=POINT
308     GO TO 70
309 902 JY=51
310     SYM=POINT
311     GO TO 80
312 903 JY=1
313     SYM=POINT
314     GO TO 80

```

```

315      60 CONTINUE
316      IF (NPRINT.EQ.1.OR.NPRINT.EQ.2) GO TO 170
317      WRITE(6,501)
318      501 FORMAT(1H1)
319      LINE=1
320      DO 140 M=1,5
321      LSTOP=LINE+9
322      WRITE(6,500) (PLOT(K,LINE),K=1,122),YSCALE(M)
323      500 FORMAT(11X,122A1,T2,F10.5)
324      LINE=LINE+1
325      DO 150 J=LINE,LSTOP
326      WRITE(6,500) (PLOT(K,J),K=1,122)
327      150 CONTINUE
328      LINE=LINE+9
329      140 CONTINUE
330      WRITE(6,500) (PLOT(K,51),K=1,122),YSCALE(6)
331      WRITE(6,500) (PLOT(K,52),K=1,122)
332      WRITE(6,504) (XSCALE(K),K=1,7)
333      504 FORMAT(8X,6(F10.5,10X),T124,F10.5)
334      WRITE(6,505) XHEAD,YHEAD
335      505 FORMAT(/,40X,'HORIZONTAL AXIS - ',5A4,/,
1      42X,'VERTICAL AXIS - ',5A4)
336      WRITE(6,506) TITLE
337      506 FORMAT(/,T48,5A4,/,T48,5A4,/,1H1)
338      170 CONTINUE
339      SYMBOL=SAVSYM
340      RETURN
341      9999 CONTINUE
342      WRITE(6,502)
343      502 FORMAT(1H1,10X,'MAX X OR Y VALUE EQUALS MIN VALUE',/////))
344      SYMBOL=SAVSYM
345      RETURN
346      END

347      SUBROUTINE SIGNIF(VALUE,NUMB,SCALE,SIG,N)
348      HIGH=10.0**NUMB
349      SCALF=0.1**NUMB
350      BSCALE=10.0
351      IF (ABS(VALUE).GE.1.0) GO TO 30
352      SCALE=10.0**NUMB
353      BSCALE=0.1
354      30 M=0
355      IF (ABS(VALUE).GE.1.0.AND.ABS(VALUE).LT.HIGH) GO TO 20
356      DO 10 M=1,25
357      VALUE=VALUE*SCALE
358      IF (ABS(VALUE).GE.1.0.AND.ABS(VALUE).LT.HIGH) GO TO 20
359      10 CONTINUE
360      20 N=M*NUMB
361      NVALUE=VALUE
362      SCALF=BSCALE
363      IF (NUMB.LT.2) GO TO 40
364      IF (ABS(VALUE).GE.10.0) GO TO 40
365      NVALUE=10.0*VALUE
366      IF (SCALE.LT.1.0) N=N+1
367      IF (SCALE.GE.1.0) N=N-1
368      40 SIG=NVALUE
369      RETURN
370      END

```

```
// $DATA
```

VALUES DERIVED USING CNOIDAL WAVE THEORY

WAVE LENGTH	=	394.000
WAVE HEIGHT	=	25.000
WATER DEPTH	=	50.000
YC	=	65.800
YT	=	40.800
WAVE CELERITY	=	37.864
WAVE PERIOD	=	10.406
K**2	=	0.894
K(K)	=	2.551
E(K)	=	1.109

X/L =0.00

Y	HORIZONTAL VELOCITY	VERTICAL VELOCITY	HORIZONTAL ACCELERATION	VERTICAL ACCELERATION
65.80	0.206369E 02	0.197083E 00	0.589981E 00	-0.192822E 02
65.00	0.202853E 02	0.190449E 00	0.575157E 00	-0.190277E 02
64.00	0.198512E 02	0.182364E 00	0.556857E 00	-0.187102E 02
63.00	0.194239E 02	0.174518E 00	0.538840E 00	-0.183938E 02
62.00	0.190033E 02	0.166908E 00	0.521106E 00	-0.180785E 02
61.00	0.185894E 02	0.159531E 00	0.503657E 00	-0.177644E 02
60.00	0.181823E 02	0.152382E 00	0.486491E 00	-0.174514E 02
59.00	0.177819E 02	0.145458E 00	0.469609E 00	-0.171394E 02
58.00	0.173882E 02	0.138755E 00	0.453010E 00	-0.168285E 02
57.00	0.170012E 02	0.132269E 00	0.436695E 00	-0.165187E 02
56.00	0.166210E 02	0.125997E 00	0.420664E 00	-0.162098E 02
55.00	0.162475E 02	0.119935E 00	0.404917E 00	-0.159020E 02
54.00	0.158808E 02	0.114079E 00	0.389454E 00	-0.155952E 02
53.00	0.155207E 02	0.108425E 00	0.374274E 00	-0.152894E 02
52.00	0.151674E 02	0.102970E 00	0.359378E 00	-0.149845E 02
51.00	0.148208E 02	0.977092E-01	0.344766E 00	-0.146805E 02
50.00	0.144810E 02	0.926398E-01	0.330437E 00	-0.143775E 02
49.00	0.141479E 02	0.877578E-01	0.316392E 00	-0.140754E 02
48.00	0.138215E 02	0.830593E-01	0.302631E 00	-0.137741E 02
47.00	0.135018E 02	0.785407E-01	0.289154E 00	-0.134738E 02
46.00	0.131889E 02	0.741982E-01	0.275960E 00	-0.131742E 02
45.00	0.128827E 02	0.700280E-01	0.263051E 00	-0.128755E 02
44.00	0.125832E 02	0.660264E-01	0.250424E 00	-0.125776E 02
43.00	0.122905E 02	0.621898E-01	0.238082E 00	-0.122805E 02
42.00	0.120045E 02	0.585142E-01	0.226023E 00	-0.119842E 02
41.00	0.117252E 02	0.549960E-01	0.214248E 00	-0.116886E 02
40.00	0.114527E 02	0.516314E-01	0.202757E 00	-0.113938E 02
39.00	0.111868E 02	0.484166E-01	0.191550E 00	-0.110997E 02
38.00	0.109277E 02	0.453480E-01	0.180626E 00	-0.108063E 02
37.00	0.106754E 02	0.424218E-01	0.169986E 00	-0.105136E 02
36.00	0.104298E 02	0.396341E-01	0.159630E 00	-0.102215E 02
35.00	0.101909E 02	0.369814E-01	0.149557E 00	-0.993015E 01
34.00	0.995868E 01	0.344598E-01	0.139768E 00	-0.963938E 01
33.00	0.973323E 01	0.320656E-01	0.130263E 00	-0.934922E 01
32.00	0.951452E 01	0.297951E-01	0.121042E 00	-0.905966E 01
31.00	0.930254E 01	0.276444E-01	0.112104E 00	-0.877068E 01
30.00	0.909729E 01	0.256099E-01	0.103451E 00	-0.848225E 01
29.00	0.889876E 01	0.236878E-01	0.950805E-01	-0.819437E 01
28.00	0.870697E 01	0.218743E-01	0.869941E-01	-0.790701E 01
27.00	0.852190E 01	0.201658E-01	0.791914E-01	-0.762015E 01
26.00	0.834356E 01	0.185584E-01	0.716725E-01	-0.733378E 01
25.00	0.817196E 01	0.170484E-01	0.644373E-01	-0.704788E 01
24.00	0.800708E 01	0.156321E-01	0.574859E-01	-0.676243E 01
23.00	0.784894E 01	0.143057E-01	0.508181E-01	-0.647742E 01
22.00	0.769752E 01	0.130655E-01	0.444341E-01	-0.619282E 01
21.00	0.755283E 01	0.119077E-01	0.383339E-01	-0.590861E 01
20.00	0.741488E 01	0.108287E-01	0.325173E-01	-0.562478E 01
19.00	0.728365E 01	0.982449E-02	0.269845E-01	-0.534132E 01
18.00	0.715915E 01	0.889154E-02	0.217355E-01	-0.505819E 01
17.00	0.704138E 01	0.802599E-02	0.167701E-01	-0.477540E 01
16.00	0.693034E 01	0.722418E-02	0.120885E-01	-0.449290E 01
15.00	0.682603E 01	0.648227E-02	0.769067E-02	-0.421070E 01
14.00	0.672845E 01	0.579661E-02	0.357654E-02	-0.392877E 01
13.00	0.663760E 01	0.516337E-02	-0.253869E-03	-0.364708E 01
12.00	0.655348E 01	0.457885E-02	-0.380054E-02	-0.336564E 01

11.00	0.647609E 01	0.403929E-02	-0.706346E-02	-0.308441E 01
10.00	0.640543E 01	0.354095E-02	-0.100427E-01	-0.280337E 01
9.00	0.634150E 01	0.308007E-02	-0.127381E-01	-0.252252E 01
8.00	0.628429E 01	0.265292E-02	-0.151499E-01	-0.224184E 01
7.00	0.623382E 01	0.225574E-02	-0.172779E-01	-0.196129E 01
6.00	0.619008E 01	0.188478E-02	-0.191221E-01	-0.168087E 01
5.00	0.615307E 01	0.153630E-02	-0.206827E-01	-0.140056E 01
4.00	0.612279E 01	0.120656E-02	-0.219594E-01	-0.112034E 01
3.00	0.609923E 01	0.891804E-03	-0.229525E-01	-0.840193E 00
2.00	0.608241E 01	0.588292E-03	-0.236618E-01	-0.560098E 00
1.00	0.607232E 01	0.292273E-03	-0.240874E-01	-0.280040E 00
0.00	0.606894E 01	0.000000E 00	-0.242293E-01	0.000000E 00

X/L =0.05

Y	HORIZONTAL VELOCITY	VERTICAL VELOCITY	HORIZONTAL ACCELERATION	VERTICAL ACCELERATION
64.24	0.170151E 02	0.764608E 01	0.216264E 02	-0.147129E 02
64.00	0.169361E 02	0.757210E 01	0.214638E 02	-0.146833E 02
63.00	0.166055E 02	0.726495E 01	0.207828E 02	-0.145554E 02
62.00	0.162800E 02	0.696672E 01	0.201126E 02	-0.144227E 02
61.00	0.159598E 02	0.667727E 01	0.194531E 02	-0.142852E 02
60.00	0.156448E 02	0.639646E 01	0.188043E 02	-0.141432E 02
59.00	0.153350E 02	0.612414E 01	0.181662E 02	-0.139965E 02
58.00	0.150304E 02	0.586018E 01	0.175389E 02	-0.138454E 02
57.00	0.147310E 02	0.560444E 01	0.169223E 02	-0.136898E 02
56.00	0.144368E 02	0.535676E 01	0.163164E 02	-0.135299E 02
55.00	0.141479E 02	0.511702E 01	0.157212E 02	-0.133658E 02
54.00	0.138641E 02	0.488506E 01	0.151368E 02	-0.131974E 02
53.00	0.135855E 02	0.466075E 01	0.145631E 02	-0.130250E 02
52.00	0.133122E 02	0.444395E 01	0.140001E 02	-0.128485E 02
51.00	0.130440E 02	0.423451E 01	0.134478E 02	-0.126680E 02
50.00	0.127811E 02	0.403229E 01	0.129062E 02	-0.124837E 02
49.00	0.125233E 02	0.383716E 01	0.123754E 02	-0.122956E 02
48.00	0.122708E 02	0.364896E 01	0.118553E 02	-0.121037E 02
47.00	0.120235E 02	0.346756E 01	0.113459E 02	-0.119082E 02
46.00	0.117813E 02	0.329281E 01	0.108473E 02	-0.117091E 02
45.00	0.115444E 02	0.312458E 01	0.103593E 02	-0.115065E 02
44.00	0.113127E 02	0.296272E 01	0.988212E 01	-0.113005E 02
43.00	0.110862E 02	0.280709E 01	0.941564E 01	-0.110911E 02
42.00	0.108649E 02	0.265755E 01	0.895987E 01	-0.108785E 02
41.00	0.106489E 02	0.251396E 01	0.851484E 01	-0.106626E 02
40.00	0.104380E 02	0.237618E 01	0.808052E 01	-0.104437E 02
39.00	0.102323E 02	0.224406E 01	0.765693E 01	-0.102217E 02
38.00	0.100318E 02	0.211746E 01	0.724407E 01	-0.999669E 01
37.00	0.983659E 01	0.199624E 01	0.684193E 01	-0.976882E 01
36.00	0.964654E 01	0.188026E 01	0.645051E 01	-0.953814E 01
35.00	0.946170E 01	0.176938E 01	0.606982E 01	-0.930472E 01
34.00	0.928206E 01	0.166346E 01	0.569985E 01	-0.906863E 01
33.00	0.910764E 01	0.156235E 01	0.534060E 01	-0.882996E 01
32.00	0.893841E 01	0.146592E 01	0.499208E 01	-0.858877E 01
31.00	0.877440E 01	0.137401E 01	0.465428E 01	-0.834515E 01
30.00	0.861559E 01	0.128650E 01	0.432720E 01	-0.809916E 01
29.00	0.846199E 01	0.120323E 01	0.401085E 01	-0.785089E 01
28.00	0.831359E 01	0.112408E 01	0.370522E 01	-0.760042E 01
27.00	0.817041E 01	0.104888E 01	0.341032E 01	-0.734782E 01
26.00	0.803243E 01	0.977511E 00	0.312614E 01	-0.709316E 01
25.00	0.789965E 01	0.909822E 00	0.285268E 01	-0.683652E 01
24.00	0.777209E 01	0.845674E 00	0.258995E 01	-0.657798E 01
23.00	0.764972E 01	0.784924E 00	0.233794E 01	-0.631761E 01
22.00	0.753257E 01	0.727431E 00	0.209666E 01	-0.605549E 01
21.00	0.742062E 01	0.673054E 00	0.186610E 01	-0.579170E 01
20.00	0.731388E 01	0.621650E 00	0.164626E 01	-0.552630E 01
19.00	0.721235E 01	0.573079E 00	0.143715E 01	-0.525939E 01
18.00	0.711602E 01	0.527199E 00	0.123876E 01	-0.499103E 01
17.00	0.702490E 01	0.483867E 00	0.105109E 01	-0.472130E 01
16.00	0.693899E 01	0.442942E 00	0.874147E 00	-0.445027E 01
15.00	0.685828E 01	0.404284E 00	0.707929E 00	-0.417803E 01
14.00	0.678279E 01	0.367749E 00	0.552434E 00	-0.390464E 01
13.00	0.671249E 01	0.333197E 00	0.407663E 00	-0.363019E 01
12.00	0.664741E 01	0.300486E 00	0.273616E 00	-0.335475E 01
11.00	0.658753E 01	0.269474E 00	0.150292E 00	-0.307840E 01

10.00	0.653286E 01	0.240021E 00	0.376925E-01	-0.280121E 01
9.00	0.648339E 01	0.211983E 00	-0.641835E-01	-0.252326E 01
8.00	0.643914E 01	0.185219E 00	-0.155336E 00	-0.224462E 01
7.00	0.640008E 01	0.159588E 00	-0.235764E 00	-0.196538E 01
6.00	0.636624E 01	0.134949E 00	-0.305468E 00	-0.168560E 01
5.00	0.633760E 01	0.111160E 00	-0.364449E 00	-0.140536E 01
4.00	0.631417E 01	0.880781E-01	-0.412706E 00	-0.112475E 01
3.00	0.629595E 01	0.655630E-01	-0.450239E 00	-0.843826E 00
2.00	0.628293E 01	0.434726E-01	-0.477049E 00	-0.562678E 00
1.00	0.627512E 01	0.216655E-01	-0.493135E 00	-0.281377E 00
0.00	0.627252E 01	0.000000E 00	-0.498496E 00	0.000000E 00

X/L =0.10

Y	HORIZONTAL VELOCITY	VERTICAL VELOCITY	HORIZONTAL ACCELERATION	VERTICAL ACCELERATION
60.31	0.981616E 01	0.105172E 02	0.244763E 02	-0.672327E 01
60.00	0.977915E 01	0.104011E 02	0.242397E 02	-0.676657E 01
59.00	0.966013E 01	0.100301E 02	0.234788E 02	-0.689915E 01
58.00	0.954311E 01	0.966915E 01	0.227307E 02	-0.701936E 01
57.00	0.942809E 01	0.931796E 01	0.219955E 02	-0.712741E 01
56.00	0.931507E 01	0.897639E 01	0.212729E 02	-0.722350E 01
55.00	0.920405E 01	0.864428E 01	0.205632E 02	-0.730786E 01
54.00	0.909503E 01	0.832146E 01	0.198663E 02	-0.738068E 01
53.00	0.898801E 01	0.800775E 01	0.191822E 02	-0.744218E 01
52.00	0.888299E 01	0.770300E 01	0.185108E 02	-0.749257E 01
51.00	0.877997E 01	0.740703E 01	0.178523E 02	-0.753206E 01
50.00	0.867895E 01	0.711966E 01	0.172065E 02	-0.756085E 01
49.00	0.857994E 01	0.684074E 01	0.165735E 02	-0.757915E 01
48.00	0.848292E 01	0.657010E 01	0.159533E 02	-0.758719E 01
47.00	0.838790E 01	0.630756E 01	0.153459E 02	-0.758516E 01
46.00	0.829488E 01	0.605295E 01	0.147513E 02	-0.757327E 01
45.00	0.820387E 01	0.580612E 01	0.141694E 02	-0.755174E 01
44.00	0.811485E 01	0.556688E 01	0.136004E 02	-0.752078E 01
43.00	0.802784E 01	0.533508E 01	0.130441E 02	-0.748058E 01
42.00	0.794282E 01	0.511053E 01	0.125007E 02	-0.743137E 01
41.00	0.785981E 01	0.489308E 01	0.119700E 02	-0.737336E 01
40.00	0.777879E 01	0.468255E 01	0.114521E 02	-0.730675E 01
39.00	0.769978E 01	0.447878E 01	0.109470E 02	-0.723175E 01
38.00	0.762276E 01	0.428159E 01	0.104546E 02	-0.714857E 01
37.00	0.754775E 01	0.409082E 01	0.997510E 01	-0.705743E 01
36.00	0.747474E 01	0.390629E 01	0.950834E 01	-0.695852E 01
35.00	0.740372E 01	0.372785E 01	0.905439E 01	-0.685207E 01
34.00	0.733471E 01	0.355531E 01	0.861321E 01	-0.673828E 01
33.00	0.726770E 01	0.338852E 01	0.818483E 01	-0.661736E 01
32.00	0.720269E 01	0.322729E 01	0.776923E 01	-0.648953E 01
31.00	0.713968E 01	0.307148E 01	0.736642E 01	-0.635498E 01
30.00	0.707867E 01	0.292089E 01	0.697640E 01	-0.621393E 01
29.00	0.701965E 01	0.277538E 01	0.659916E 01	-0.606659E 01
28.00	0.696264E 01	0.263476E 01	0.623472E 01	-0.591317E 01
27.00	0.690763E 01	0.249887E 01	0.588306E 01	-0.575388E 01
26.00	0.685462E 01	0.236753E 01	0.554419E 01	-0.558893E 01
25.00	0.680361E 01	0.224059E 01	0.521810E 01	-0.541853E 01
24.00	0.675461E 01	0.211787E 01	0.490481E 01	-0.524289E 01
23.00	0.670760E 01	0.199920E 01	0.460430E 01	-0.506221E 01
22.00	0.666259E 01	0.188442E 01	0.431657E 01	-0.487671E 01
21.00	0.661958E 01	0.177335E 01	0.404164E 01	-0.468660E 01
20.00	0.657857E 01	0.166582E 01	0.377949E 01	-0.449208E 01
19.00	0.653957E 01	0.156168E 01	0.353014E 01	-0.429337E 01
18.00	0.650256E 01	0.146074E 01	0.329356E 01	-0.409068E 01
17.00	0.646756E 01	0.136284E 01	0.306978E 01	-0.388421E 01
16.00	0.643455E 01	0.126782E 01	0.285878E 01	-0.367418E 01
15.00	0.640354E 01	0.117549E 01	0.266058E 01	-0.346080E 01
14.00	0.637454E 01	0.108570E 01	0.247516E 01	-0.324426E 01
13.00	0.634753E 01	0.998269E 00	0.230252E 01	-0.302480E 01
12.00	0.632253E 01	0.913037E 00	0.214268E 01	-0.280260E 01
11.00	0.629952E 01	0.829829E 00	0.199562E 01	-0.257790E 01
10.00	0.627852E 01	0.748481E 00	0.186135E 01	-0.235088E 01
9.00	0.625952E 01	0.668820E 00	0.173987E 01	-0.212177E 01
8.00	0.624251E 01	0.590679E 00	0.163117E 01	-0.189077E 01
7.00	0.622751E 01	0.513889E 00	0.153527E 01	-0.165809E 01

A=1.0



6.00	0.621451E 01	0.438281E 00	0.145215E 01	-0.142395E 01
5.00	0.620351E 01	0.363686E 00	0.138181E 01	-0.118855E 01
4.00	0.619451E 01	0.289936E 00	0.132427E 01	-0.952094E 00
3.00	0.618751E 01	0.216861E 00	0.127951E 01	-0.714805E 00
2.00	0.618250E 01	0.144293E 00	0.124754E 01	-0.476886E 00
1.00	0.617950E 01	0.720618E-01	0.122836E 01	-0.238548E 00
0.00	0.617850E 01	0.000000E 00	0.122197E 01	0.000000E 00

X/L =0.15

Y	HORIZONTAL VELOCITY	VERTICAL VELOCITY	HORIZONTAL ACCELERATION	VERTICAL ACCELERATION
55.84	0.414501E 01	0.100848E 02	0.170638E 02	-0.127708E 01
55.00	0.417120E 01	0.983566E 01	0.166637E 02	-0.145018E 01
54.00	0.420175E 01	0.954587E 01	0.161969E 02	-0.164416E 01
53.00	0.423175E 01	0.926220E 01	0.157387E 02	-0.182600E 01
52.00	0.426118E 01	0.898451E 01	0.152890E 02	-0.199595E 01
51.00	0.429005E 01	0.871271E 01	0.148479E 02	-0.215421E 01
50.00	0.431837E 01	0.844667E 01	0.144153E 02	-0.230101E 01
49.00	0.434612E 01	0.818629E 01	0.139913E 02	-0.243659E 01
48.00	0.437331E 01	0.793146E 01	0.135759E 02	-0.256116E 01
47.00	0.439994E 01	0.768205E 01	0.131691E 02	-0.267495E 01
46.00	0.442601E 01	0.743796E 01	0.127708E 02	-0.277818E 01
45.00	0.445151E 01	0.719907E 01	0.123811E 02	-0.287108E 01
44.00	0.447646E 01	0.696527E 01	0.119999E 02	-0.295387E 01
43.00	0.450085E 01	0.673645E 01	0.116273E 02	-0.302678E 01
42.00	0.452468E 01	0.651249E 01	0.112633E 02	-0.309004E 01
41.00	0.454794E 01	0.629328E 01	0.109079E 02	-0.314386E 01
40.00	0.457065E 01	0.607871E 01	0.105610E 02	-0.318847E 01
39.00	0.459279E 01	0.586866E 01	0.102227E 02	-0.322409E 01
38.00	0.461438E 01	0.566302E 01	0.989289E 01	-0.325096E 01
37.00	0.463540E 01	0.546169E 01	0.957170E 01	-0.326928E 01
36.00	0.465586E 01	0.526453E 01	0.925907E 01	-0.327930E 01
35.00	0.467577E 01	0.507145E 01	0.895501E 01	-0.328124E 01
34.00	0.469511E 01	0.488233E 01	0.865951E 01	-0.327531E 01
33.00	0.471389E 01	0.469705E 01	0.837257E 01	-0.326175E 01
32.00	0.473211E 01	0.451551E 01	0.809421E 01	-0.324077E 01
31.00	0.474977E 01	0.433758E 01	0.782440E 01	-0.321261E 01
30.00	0.476687E 01	0.416316E 01	0.756316E 01	-0.317748E 01
29.00	0.478341E 01	0.399214E 01	0.731049E 01	-0.313561E 01
28.00	0.479939E 01	0.382439E 01	0.706638E 01	-0.308723E 01
27.00	0.481480E 01	0.365981E 01	0.683084E 01	-0.303257E 01
26.00	0.482966E 01	0.349829E 01	0.660386E 01	-0.297184E 01
25.00	0.484396E 01	0.333970E 01	0.638545E 01	-0.290526E 01
24.00	0.485769E 01	0.318394E 01	0.617560E 01	-0.283308E 01
23.00	0.487087E 01	0.303090E 01	0.597432E 01	-0.275550E 01
22.00	0.488348E 01	0.288046E 01	0.578160E 01	-0.267275E 01
21.00	0.489553E 01	0.273251E 01	0.559745E 01	-0.258507E 01
20.00	0.490703E 01	0.258693E 01	0.542186E 01	-0.249267E 01
19.00	0.491796E 01	0.244362E 01	0.525484E 01	-0.239577E 01
18.00	0.492833E 01	0.230245E 01	0.509638E 01	-0.229461E 01
17.00	0.493814E 01	0.216332E 01	0.494649E 01	-0.218941E 01
16.00	0.494739E 01	0.202611E 01	0.480517E 01	-0.208038E 01
15.00	0.495608E 01	0.189072E 01	0.467241E 01	-0.196777E 01
14.00	0.496421E 01	0.175701E 01	0.454821E 01	-0.185178E 01
13.00	0.497178E 01	0.162490E 01	0.443258E 01	-0.173265E 01
12.00	0.497879E 01	0.149425E 01	0.432551E 01	-0.161060E 01
11.00	0.498523E 01	0.136496E 01	0.422702E 01	-0.148585E 01
10.00	0.499112E 01	0.123691E 01	0.413708E 01	-0.135864E 01
9.00	0.499645E 01	0.111000E 01	0.405571E 01	-0.122917E 01
8.00	0.500121E 01	0.984102E 00	0.398291E 01	-0.109769E 01
7.00	0.500542E 01	0.859110E 00	0.391867E 01	-0.964410E 00
6.00	0.500906E 01	0.734909E 00	0.386299E 01	-0.829557E 00
5.00	0.501214E 01	0.611388E 00	0.381589E 01	-0.693357E 00
4.00	0.501467E 01	0.488432E 00	0.377734E 01	-0.556033E 00
3.00	0.501663E 01	0.365928E 00	0.374736E 01	-0.417811E 00
2.00	0.501803E 01	0.243763E 00	0.372595E 01	-0.278915E 00

1.00  
0.00

0.501887E 01  
0.501915E 01

0.121825E 00  
0.000000E 00

0.371310E 01  
0.370882E 01

-0.139570E 00  
0.000000E 00

X/L = 0.20

Y	HORIZONTAL VELOCITY	VERTICAL VELOCITY	HORIZONTAL ACCELERATION	VERTICAL ACCELERATION
52.55	0.108536E 01	0.896978E 01	0.112990E 02	0.130707E 01
52.00	0.113478E 01	0.884561E 01	0.111685E 02	0.120505E 01
51.00	0.122289E 01	0.862326E 01	0.109357E 02	0.102748E 01
50.00	0.130929E 01	0.840395E 01	0.107075E 02	0.858908E 00
49.00	0.139398E 01	0.818763E 01	0.104839E 02	0.699150E 00
48.00	0.147697E 01	0.797423E 01	0.102647E 02	0.548033E 00
47.00	0.155824E 01	0.776370E 01	0.100501E 02	0.405381E 00
46.00	0.163779E 01	0.755596E 01	0.983994E 01	0.271018E 00
45.00	0.171564E 01	0.735098E 01	0.963433E 01	0.144767E 00
44.00	0.179178E 01	0.714868E 01	0.943324E 01	0.264516E-01
43.00	0.186620E 01	0.694900E 01	0.923668E 01	-0.841043E-01
42.00	0.193892E 01	0.675189E 01	0.904463E 01	-0.187077E 00
41.00	0.200992E 01	0.655729E 01	0.885710E 01	-0.282643E 00
40.00	0.207922E 01	0.636514E 01	0.867409E 01	-0.370979E 00
39.00	0.214680E 01	0.617536E 01	0.849560E 01	-0.452260E 00
38.00	0.221267E 01	0.598792E 01	0.832162E 01	-0.526665E 00
37.00	0.227683E 01	0.580274E 01	0.815217E 01	-0.594367E 00
36.00	0.233928E 01	0.561978E 01	0.798723E 01	-0.655545E 00
35.00	0.240002E 01	0.543896E 01	0.782681E 01	-0.710374E 00
34.00	0.245904E 01	0.526023E 01	0.767091E 01	-0.759031E 00
33.00	0.251636E 01	0.508353E 01	0.751953E 01	-0.801692E 00
32.00	0.257197E 01	0.490880E 01	0.737267E 01	-0.838533E 00
31.00	0.262586E 01	0.473597E 01	0.723033E 01	-0.869731E 00
30.00	0.267805E 01	0.456500E 01	0.709251E 01	-0.895462E 00
29.00	0.272852E 01	0.439582E 01	0.695920E 01	-0.915903E 00
28.00	0.277728E 01	0.422836E 01	0.683042E 01	-0.931229E 00
27.00	0.282433E 01	0.406258E 01	0.670615E 01	-0.941618E 00
26.00	0.286967E 01	0.389841E 01	0.658640E 01	-0.947245E 00
25.00	0.291330E 01	0.373579E 01	0.647117E 01	-0.948285E 00
24.00	0.295522E 01	0.357466E 01	0.636046E 01	-0.944919E 00
23.00	0.299542E 01	0.341497E 01	0.625427E 01	-0.937320E 00
22.00	0.303392E 01	0.325664E 01	0.615260E 01	-0.925664E 00
21.00	0.307070E 01	0.309964E 01	0.605544E 01	-0.910130E 00
20.00	0.310578E 01	0.294388E 01	0.596281E 01	-0.890893E 00
19.00	0.313914E 01	0.278932E 01	0.587469E 01	-0.868127E 00
18.00	0.317080E 01	0.263589E 01	0.579109E 01	-0.842011E 00
17.00	0.320074E 01	0.248353E 01	0.571202E 01	-0.812719E 00
16.00	0.322897E 01	0.233219E 01	0.563745E 01	-0.780432E 00
15.00	0.325549E 01	0.218180E 01	0.556741E 01	-0.745322E 00
14.00	0.328029E 01	0.203231E 01	0.550189E 01	-0.707568E 00
13.00	0.330339E 01	0.188366E 01	0.544089E 01	-0.667343E 00
12.00	0.332478E 01	0.173577E 01	0.538440E 01	-0.624827E 00
11.00	0.334446E 01	0.158861E 01	0.533244E 01	-0.580194E 00
10.00	0.336242E 01	0.144210E 01	0.528499E 01	-0.533621E 00
9.00	0.337867E 01	0.129619E 01	0.524206E 01	-0.485285E 00
8.00	0.339322E 01	0.115082E 01	0.520365E 01	-0.435362E 00
7.00	0.340605E 01	0.100592E 01	0.516976E 01	-0.384028E 00
6.00	0.341717E 01	0.861443E 00	0.514039E 01	-0.331459E 00
5.00	0.342658E 01	0.717323E 00	0.511553E 01	-0.277833E 00
4.00	0.343428E 01	0.573500E 00	0.509520E 01	-0.223324E 00
3.00	0.344027E 01	0.429916E 00	0.507938E 01	-0.168110E 00
2.00	0.344454E 01	0.286511E 00	0.506809E 01	-0.112367E 00
1.00	0.344711E 01	0.143226E 00	0.506131E 01	-0.562720E-01
0.00	0.344797E 01	0.000000E 00	0.505905E 01	0.000000E 00

UM=0.0  
=1.0

X/L = 0.25

Y	HORIZONTAL VELOCITY	VERTICAL VELOCITY	HORIZONTAL ACCELERATION	VERTICAL ACCELERATION
49.78	-0.106853E 01	0.769051E 01	0.737255E 01	0.272625E 01
49.00	-0.984205E 00	0.755831E 01	0.731690E 01	0.261038E 01
48.00	-0.877760E 00	0.738922E 01	0.724666E 01	0.246652E 01
47.00	-0.773511E 00	0.722104E 01	0.717786E 01	0.232826E 01
46.00	-0.671455E 00	0.705377E 01	0.711051E 01	0.219549E 01
45.00	-0.571596E 00	0.688737E 01	0.704461E 01	0.206808E 01
44.00	-0.473928E 00	0.672184E 01	0.698016E 01	0.194594E 01
43.00	-0.378458E 00	0.655714E 01	0.691715E 01	0.182892E 01
42.00	-0.285183E 00	0.639327E 01	0.685560E 01	0.171693E 01
41.00	-0.194101E 00	0.623020E 01	0.679549E 01	0.160984E 01
40.00	-0.105215E 00	0.606792E 01	0.673683E 01	0.150754E 01
39.00	-0.185227E-01	0.590640E 01	0.667962E 01	0.140991E 01
38.00	0.659744E-01	0.574562E 01	0.662386E 01	0.131682E 01
37.00	0.148277E 00	0.558558E 01	0.656955E 01	0.122818E 01
36.00	0.228385E 00	0.542624E 01	0.651668E 01	0.114386E 01
35.00	0.306298E 00	0.526759E 01	0.646526E 01	0.106373E 01
34.00	0.382016E 00	0.510961E 01	0.641529E 01	0.987695E 00
33.00	0.455540E 00	0.495228E 01	0.636678E 01	0.915627E 00
32.00	0.526869E 00	0.479558E 01	0.631970E 01	0.847412E 00
31.00	0.596003E 00	0.463949E 01	0.627408E 01	0.782932E 00
30.00	0.662942E 00	0.448400E 01	0.622991E 01	0.722071E 00
29.00	0.727687E 00	0.432908E 01	0.618718E 01	0.664712E 00
28.00	0.790237E 00	0.417471E 01	0.614590E 01	0.610739E 00
27.00	0.850592E 00	0.402088E 01	0.610607E 01	0.560034E 00
26.00	0.908752E 00	0.386757E 01	0.606769E 01	0.512481E 00
25.00	0.964718E 00	0.371475E 01	0.603076E 01	0.467963E 00
24.00	0.101849E 01	0.356241E 01	0.599527E 01	0.426364E 00
23.00	0.107006E 01	0.341053E 01	0.596124E 01	0.387567E 00
22.00	0.111945E 01	0.325909E 01	0.592865E 01	0.351454E 00
21.00	0.116663E 01	0.310807E 01	0.589751E 01	0.317910E 00
20.00	0.121163E 01	0.295746E 01	0.586782E 01	0.286817E 00
19.00	0.125442E 01	0.280722E 01	0.583957E 01	0.258059E 00
18.00	0.129502E 01	0.265735E 01	0.581278E 01	0.231519E 00
17.00	0.133343E 01	0.250782E 01	0.578743E 01	0.207080E 00
16.00	0.136965E 01	0.235862E 01	0.576353E 01	0.184626E 00
15.00	0.140366E 01	0.220972E 01	0.574109E 01	0.164040E 00
14.00	0.143549E 01	0.206111E 01	0.572008E 01	0.145204E 00
13.00	0.146512E 01	0.191277E 01	0.570053E 01	0.128003E 00
12.00	0.149255E 01	0.176468E 01	0.568243E 01	0.112320E 00
11.00	0.151779E 01	0.161682E 01	0.566577E 01	0.980378E-01
10.00	0.154084E 01	0.146916E 01	0.565056E 01	0.850394E-01
9.00	0.156169E 01	0.132170E 01	0.563680E 01	0.732084E-01
8.00	0.158034E 01	0.117441E 01	0.562449E 01	0.624281E-01
7.00	0.159680E 01	0.102728E 01	0.561363E 01	0.525817E-01
6.00	0.161107E 01	0.880275E 00	0.560421E 01	0.435524E-01
5.00	0.162314E 01	0.733387E 00	0.559625E 01	0.352236E-01
4.00	0.163301E 01	0.586595E 00	0.558973E 01	0.274784E-01
3.00	0.164069E 01	0.439879E 00	0.558466E 01	0.202002E-01
2.00	0.164618E 01	0.293221E 00	0.558104E 01	0.132723E-01
1.00	0.164947E 01	0.146601E 00	0.557887E 01	0.657776E-02
0.00	0.165057E 01	0.000000E 00	0.557814E 01	0.000000E 00

X/L =0.30

Y	HORIZONTAL VELOCITY	VERTICAL VELOCITY	HORIZONTAL ACCELERATION	VERTICAL ACCELERATION
47.00	-0.304679E 01	0.608998E 01	0.445978E 01	0.338938E 01
47.00	-0.304642E 01	0.608956E 01	0.445992E 01	0.338898E 01
46.00	-0.294255E 01	0.596753E 01	0.449718E 01	0.327745E 01
45.00	-0.284091E 01	0.584503E 01	0.453363E 01	0.316846E 01
44.00	-0.274151E 01	0.572204E 01	0.456929E 01	0.306197E 01
43.00	-0.264434E 01	0.559859E 01	0.460414E 01	0.295790E 01
42.00	-0.254941E 01	0.547469E 01	0.463820E 01	0.285621E 01
41.00	-0.245671E 01	0.535034E 01	0.467145E 01	0.275685E 01
40.00	-0.236624E 01	0.522556E 01	0.470390E 01	0.265975E 01
39.00	-0.227801E 01	0.510035E 01	0.473555E 01	0.256486E 01
38.00	-0.219201E 01	0.497473E 01	0.476640E 01	0.247213E 01
37.00	-0.210824E 01	0.484871E 01	0.479644E 01	0.238150E 01
36.00	-0.202671E 01	0.472230E 01	0.482569E 01	0.229292E 01
35.00	-0.194741E 01	0.459551E 01	0.485413E 01	0.220633E 01
34.00	-0.187034E 01	0.446834E 01	0.488177E 01	0.212167E 01
33.00	-0.179551E 01	0.434082E 01	0.490862E 01	0.203889E 01
32.00	-0.172291E 01	0.421295E 01	0.493466E 01	0.195794E 01
31.00	-0.165255E 01	0.408474E 01	0.495990E 01	0.187875E 01
30.00	-0.158442E 01	0.395620E 01	0.498433E 01	0.180128E 01
29.00	-0.151852E 01	0.382734E 01	0.500798E 01	0.172547E 01
28.00	-0.145486E 01	0.369818E 01	0.503081E 01	0.165127E 01
27.00	-0.139343E 01	0.356872E 01	0.505284E 01	0.157861E 01
26.00	-0.133424E 01	0.343898E 01	0.507407E 01	0.150744E 01
25.00	-0.127728E 01	0.330896E 01	0.509451E 01	0.143771E 01
24.00	-0.122255E 01	0.317867E 01	0.511414E 01	0.136937E 01
23.00	-0.117006E 01	0.304813E 01	0.513297E 01	0.130235E 01
22.00	-0.111979E 01	0.291735E 01	0.515099E 01	0.123660E 01
21.00	-0.107177E 01	0.278634E 01	0.516822E 01	0.117207E 01
20.00	-0.102598E 01	0.265510E 01	0.518465E 01	0.110870E 01
19.00	-0.982419E 00	0.252365E 01	0.520027E 01	0.104644E 01
18.00	-0.941094E 00	0.239200E 01	0.521510E 01	0.985224E 00
17.00	-0.902003E 00	0.226016E 01	0.522912E 01	0.925006E 00
16.00	-0.865146E 00	0.212814E 01	0.524234E 01	0.865728E 00
15.00	-0.830522E 00	0.199596E 01	0.525476E 01	0.807335E 00
14.00	-0.798132E 00	0.186361E 01	0.526638E 01	0.749771E 00
13.00	-0.767977E 00	0.173111E 01	0.527719E 01	0.692981E 00
12.00	-0.740054E 00	0.159848E 01	0.528721E 01	0.636910E 00
11.00	-0.714366E 00	0.146572E 01	0.529642E 01	0.581503E 00
10.00	-0.690911E 00	0.133284E 01	0.530484E 01	0.526703E 00
9.00	-0.669691E 00	0.119986E 01	0.531245E 01	0.472457E 00
8.00	-0.650703E 00	0.106678E 01	0.531926E 01	0.418709E 00
7.00	-0.633951E 00	0.933618E 00	0.532527E 01	0.365403E 00
6.00	-0.619431E 00	0.800382E 00	0.533048E 01	0.312483E 00
5.00	-0.607145E 00	0.667082E 00	0.533488E 01	0.259896E 00
4.00	-0.597093E 00	0.533729E 00	0.533849E 01	0.207585E 00
3.00	-0.589276E 00	0.400334E 00	0.534130E 01	0.155495E 00
2.00	-0.583691E 00	0.266907E 00	0.534330E 01	0.103571E 00
1.00	-0.580341E 00	0.133459E 00	0.534450E 01	0.517580E-01
0.00	-0.579223E 00	0.000000E 00	0.534490E 01	0.000000E 00

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X/L =0.35

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44.50	-0.483055E 01	0.431717E 01	0.257084E 01	0.321537E 01
44.00	-0.478874E 01	0.427628E 01	0.261051E 01	0.317583E 01
43.00	-0.470664E 01	0.419384E 01	0.268841E 01	0.309717E 01
42.00	-0.462642E 01	0.411038E 01	0.276451E 01	0.301896E 01
41.00	-0.454810E 01	0.402592E 01	0.283883E 01	0.294119E 01
40.00	-0.447166E 01	0.394050E 01	0.291135E 01	0.286384E 01
39.00	-0.439710E 01	0.385413E 01	0.298208E 01	0.278691E 01
38.00	-0.432444E 01	0.376684E 01	0.305102E 01	0.271038E 01
37.00	-0.425366E 01	0.367865E 01	0.311818E 01	0.263425E 01
36.00	-0.418477E 01	0.358958E 01	0.318354E 01	0.255851E 01
35.00	-0.411777E 01	0.349966E 01	0.324710E 01	0.248313E 01
34.00	-0.405265E 01	0.340892E 01	0.330888E 01	0.240812E 01
33.00	-0.398942E 01	0.331737E 01	0.336887E 01	0.233347E 01
32.00	-0.392808E 01	0.322504E 01	0.342707E 01	0.225916E 01
31.00	-0.386863E 01	0.313196E 01	0.348347E 01	0.218517E 01
30.00	-0.381106E 01	0.303814E 01	0.353809E 01	0.211152E 01
29.00	-0.375539E 01	0.294361E 01	0.359092E 01	0.203817E 01
28.00	-0.370159E 01	0.284839E 01	0.364195E 01	0.196512E 01
27.00	-0.364969E 01	0.275252E 01	0.369119E 01	0.189237E 01
26.00	-0.359967E 01	0.265600E 01	0.373865E 01	0.181990E 01
25.00	-0.355155E 01	0.255888E 01	0.378431E 01	0.174769E 01
24.00	-0.350530E 01	0.246115E 01	0.382818E 01	0.167575E 01
23.00	-0.346095E 01	0.236287E 01	0.387026E 01	0.160405E 01
22.00	-0.341848E 01	0.226404E 01	0.391055E 01	0.153260E 01
21.00	-0.337790E 01	0.216468E 01	0.394906E 01	0.146137E 01
20.00	-0.333921E 01	0.206484E 01	0.398576E 01	0.139036E 01
19.00	-0.330241E 01	0.196451E 01	0.402068E 01	0.131956E 01
18.00	-0.326749E 01	0.186374E 01	0.405381E 01	0.124896E 01
17.00	-0.323446E 01	0.176255E 01	0.408515E 01	0.117854E 01
16.00	-0.320332E 01	0.166095E 01	0.411469E 01	0.110830E 01
15.00	-0.317406E 01	0.155897E 01	0.414245E 01	0.103823E 01
14.00	-0.314670E 01	0.145664E 01	0.416841E 01	0.968308E 00
13.00	-0.312122E 01	0.135398E 01	0.419259E 01	0.898535E 00
12.00	-0.309762E 01	0.125101E 01	0.421497E 01	0.828897E 00
11.00	-0.307592E 01	0.114775E 01	0.423556E 01	0.759385E 00
10.00	-0.305610E 01	0.104424E 01	0.425437E 01	0.689986E 00
9.00	-0.303817E 01	0.940491E 00	0.427138E 01	0.620691E 00
8.00	-0.302213E 01	0.836528E 00	0.428660E 01	0.551490E 00
7.00	-0.300797E 01	0.732376E 00	0.430003E 01	0.482372E 00
6.00	-0.299571E 01	0.628058E 00	0.431167E 01	0.413327E 00
5.00	-0.298532E 01	0.523598E 00	0.432152E 01	0.344344E 00
4.00	-0.297683E 01	0.419021E 00	0.432958E 01	0.275413E 00
3.00	-0.297023E 01	0.314348E 00	0.433584E 01	0.206523E 00
2.00	-0.296551E 01	0.209605E 00	0.434032E 01	0.137665E 00
1.00	-0.296268E 01	0.104814E 00	0.434301E 01	0.688272E-01
0.00	-0.296173E 01	0.000000E 00	0.434390E 01	0.000000E 00



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Y	HORIZONTAL VELOCITY	VERTICAL VELOCITY	HORIZONTAL ACCELERATION	VERTICAL ACCELERATION
42.51	-0.632744E 01	0.260449E 01	0.138206E 01	0.246347E 01
42.00	-0.629799E 01	0.257960E 01	0.141790E 01	0.243694E 01
41.00	-0.624176E 01	0.253053E 01	0.148633E 01	0.238503E 01
40.00	-0.618688E 01	0.248057E 01	0.155312E 01	0.233268E 01
39.00	-0.613336E 01	0.242974E 01	0.161826E 01	0.227989E 01
38.00	-0.608120E 01	0.237806E 01	0.168174E 01	0.222669E 01
37.00	-0.603039E 01	0.232555E 01	0.174358E 01	0.217307E 01
36.00	-0.598093E 01	0.227223E 01	0.180377E 01	0.211906E 01
35.00	-0.593284E 01	0.221813E 01	0.186231E 01	0.206466E 01
34.00	-0.588609E 01	0.216327E 01	0.191920E 01	0.200988E 01
33.00	-0.584070E 01	0.210767E 01	0.197445E 01	0.195473E 01
32.00	-0.579666E 01	0.205135E 01	0.202804E 01	0.189923E 01
31.00	-0.575398E 01	0.199434E 01	0.207999E 01	0.184339E 01
30.00	-0.571266E 01	0.193664E 01	0.213028E 01	0.178721E 01
29.00	-0.567269E 01	0.187830E 01	0.217893E 01	0.173071E 01
28.00	-0.563407E 01	0.181932E 01	0.222592E 01	0.167389E 01
27.00	-0.559681E 01	0.175974E 01	0.227127E 01	0.161678E 01
26.00	-0.556090E 01	0.169956E 01	0.231497E 01	0.155937E 01
25.00	-0.552635E 01	0.163882E 01	0.235702E 01	0.150168E 01
24.00	-0.549316E 01	0.157754E 01	0.239742E 01	0.144373E 01
23.00	-0.546132E 01	0.151573E 01	0.243618E 01	0.138551E 01
22.00	-0.543083E 01	0.145342E 01	0.247328E 01	0.132705E 01
21.00	-0.540170E 01	0.139063E 01	0.250873E 01	0.126835E 01
20.00	-0.537393E 01	0.132739E 01	0.254254E 01	0.120943E 01
19.00	-0.534750E 01	0.126371E 01	0.257469E 01	0.115028E 01
18.00	-0.532244E 01	0.119962E 01	0.260520E 01	0.109094E 01
17.00	-0.529873E 01	0.113513E 01	0.263406E 01	0.103140E 01
16.00	-0.527637E 01	0.107027E 01	0.266127E 01	0.971678E 00
15.00	-0.525537E 01	0.100507E 01	0.268683E 01	0.911783E 00
14.00	-0.523572E 01	0.939538E 00	0.271074E 01	0.851726E 00
13.00	-0.521743E 01	0.873702E 00	0.273300E 01	0.791518E 00
12.00	-0.520049E 01	0.807583E 00	0.275362E 01	0.731171E 00
11.00	-0.518491E 01	0.741202E 00	0.277258E 01	0.670695E 00
10.00	-0.517068E 01	0.674583E 00	0.278989E 01	0.610099E 00
9.00	-0.515781E 01	0.607745E 00	0.280556E 01	0.549396E 00
8.00	-0.514629E 01	0.540711E 00	0.281958E 01	0.488596E 00
7.00	-0.513614E 01	0.473504E 00	0.283195E 01	0.427710E 00
6.00	-0.512733E 01	0.406143E 00	0.284266E 01	0.366749E 00
5.00	-0.511987E 01	0.338652E 00	0.285173E 01	0.305723E 00
4.00	-0.511378E 01	0.271052E 00	0.285915E 01	0.244643E 00
3.00	-0.510904E 01	0.203366E 00	0.286493E 01	0.183520E 00
2.00	-0.510565E 01	0.135613E 00	0.286905E 01	0.122365E 00
1.00	-0.510362E 01	0.678176E-01	0.287152E 01	0.611877E-01
0.00	-0.510294E 01	0.000000E 00	0.287234E 01	0.000000E 00

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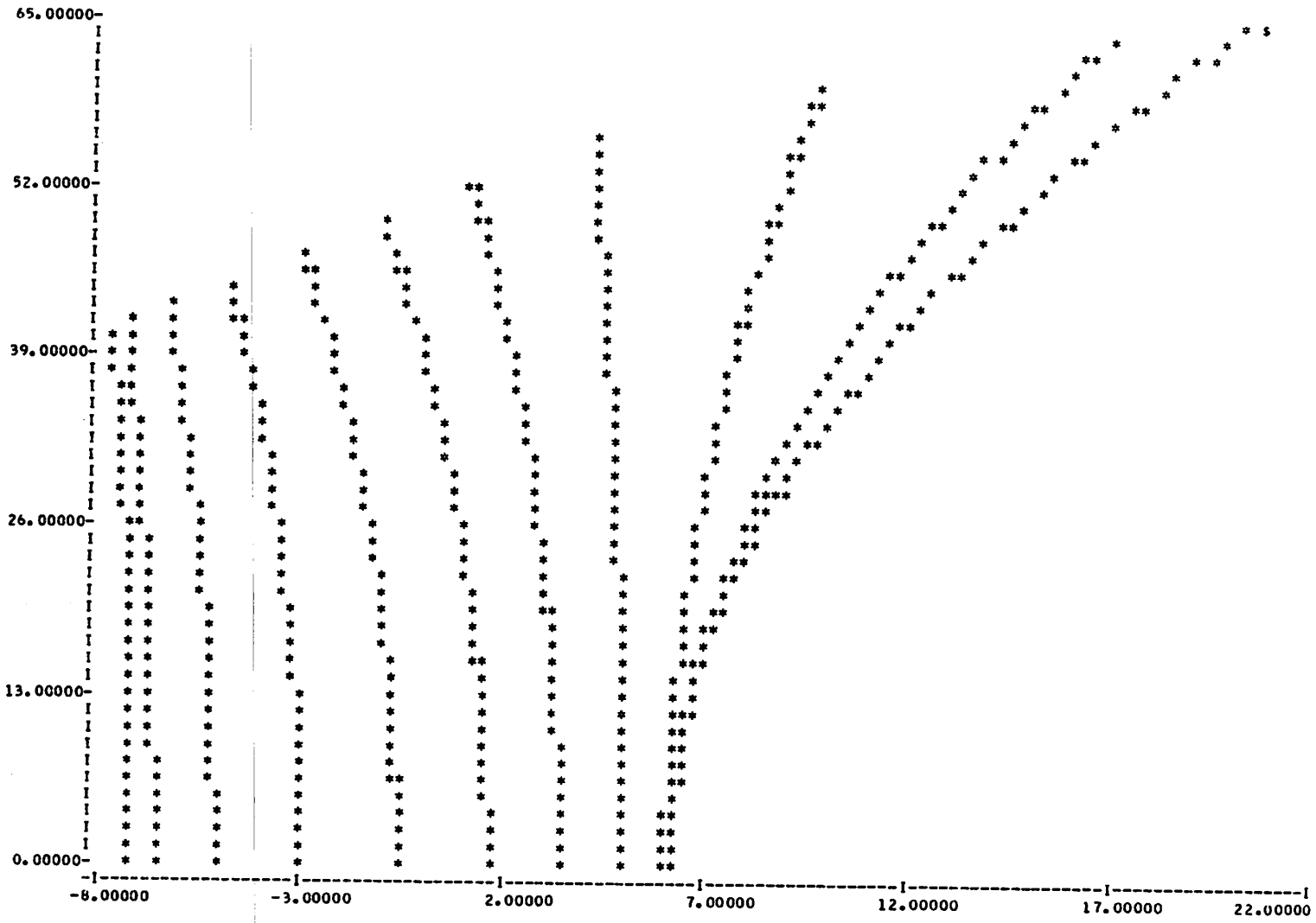


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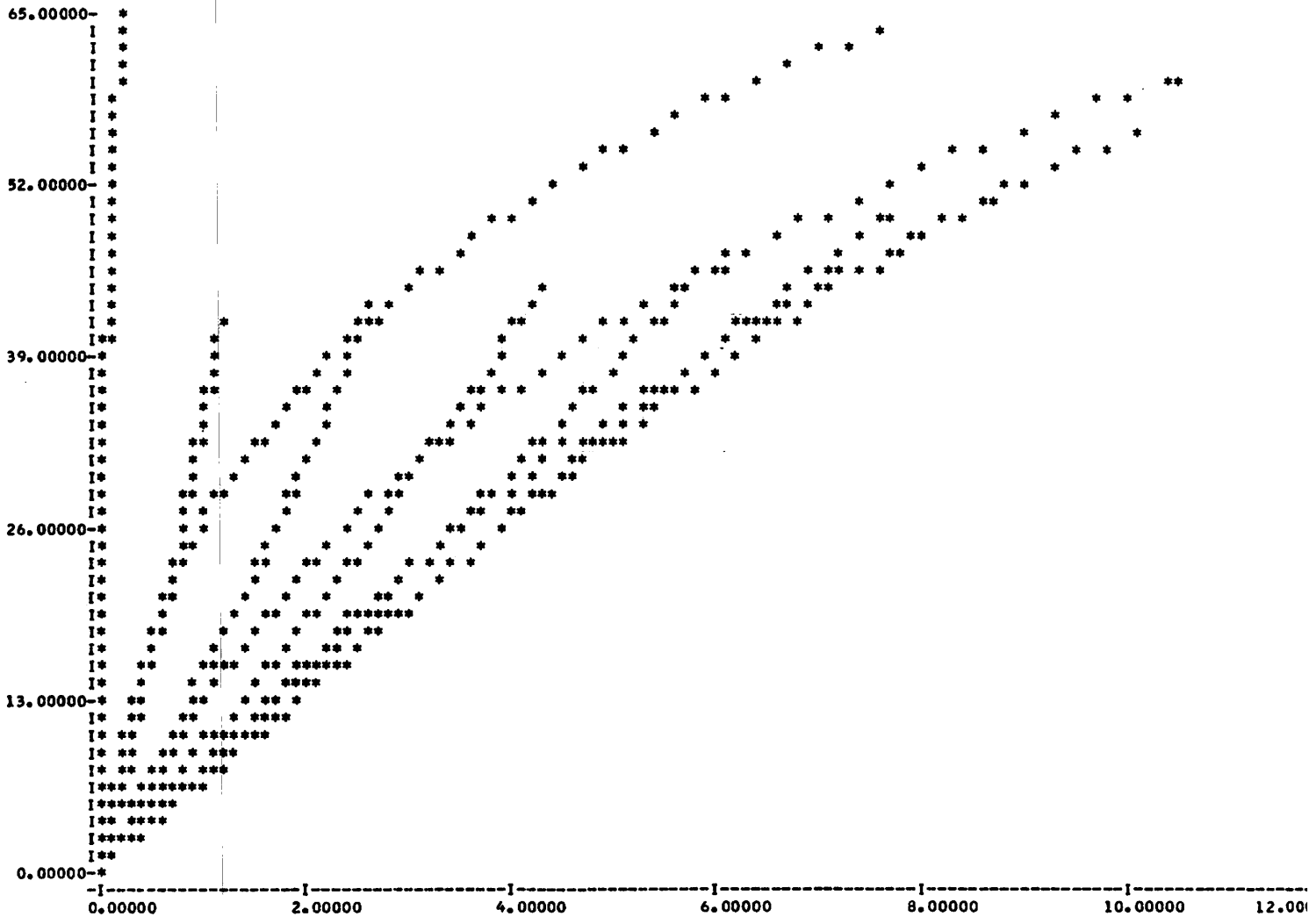
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41.24	-0.735376E 01	0.116408E 01	0.591436E 00	0.166040E 01
41.00	-0.734498E 01	0.115892E 01	0.600250E 00	0.165277E 01
40.00	-0.730882E 01	0.113705E 01	0.636559E 00	0.162049E 01
39.00	-0.727355E 01	0.111470E 01	0.671972E 00	0.158762E 01
38.00	-0.723917E 01	0.109190E 01	0.706489E 00	0.155417E 01
37.00	-0.720569E 01	0.106864E 01	0.740109E 00	0.152015E 01
36.00	-0.717310E 01	0.104494E 01	0.772832E 00	0.148558E 01
35.00	-0.714140E 01	0.102082E 01	0.804659E 00	0.145048E 01
34.00	-0.711059E 01	0.996280E 00	0.835590E 00	0.141486E 01
33.00	-0.708068E 01	0.971341E 00	0.865624E 00	0.137873E 01
32.00	-0.705166E 01	0.946010E 00	0.894761E 00	0.134210E 01
31.00	-0.702353E 01	0.920301E 00	0.923001E 00	0.130501E 01
30.00	-0.699630E 01	0.894225E 00	0.950346E 00	0.126745E 01
29.00	-0.696996E 01	0.867793E 00	0.976793E 00	0.122944E 01
28.00	-0.694451E 01	0.841018E 00	0.100234E 01	0.119101E 01
27.00	-0.691996E 01	0.813912E 00	0.102700E 01	0.115215E 01
26.00	-0.689630E 01	0.786486E 00	0.105076E 01	0.111290E 01
25.00	-0.687353E 01	0.758753E 00	0.107362E 01	0.107326E 01
24.00	-0.685165E 01	0.730723E 00	0.109558E 01	0.103324E 01
23.00	-0.683067E 01	0.702409E 00	0.111665E 01	0.992871E 00
22.00	-0.681058E 01	0.673823E 00	0.113682E 01	0.952158E 00
21.00	-0.679138E 01	0.644976E 00	0.115610E 01	0.911117E 00
20.00	-0.677308E 01	0.615881E 00	0.117448E 01	0.869764E 00
19.00	-0.675566E 01	0.586549E 00	0.119196E 01	0.828114E 00
18.00	-0.673914E 01	0.556992E 00	0.120855E 01	0.786180E 00
17.00	-0.672352E 01	0.527222E 00	0.122424E 01	0.743979E 00
16.00	-0.670879E 01	0.497251E 00	0.123903E 01	0.701525E 00
15.00	-0.669495E 01	0.467090E 00	0.125292E 01	0.658833E 00
14.00	-0.668200E 01	0.436752E 00	0.126592E 01	0.615918E 00
13.00	-0.666994E 01	0.406248E 00	0.127803E 01	0.572794E 00
12.00	-0.665878E 01	0.375590E 00	0.128924E 01	0.529477E 00
11.00	-0.664851E 01	0.344790E 00	0.129954E 01	0.485981E 00
10.00	-0.663914E 01	0.313860E 00	0.130896E 01	0.442322E 00
9.00	-0.663066E 01	0.282812E 00	0.131748E 01	0.398514E 00
8.00	-0.662307E 01	0.251656E 00	0.132510E 01	0.354572E 00
7.00	-0.661637E 01	0.220406E 00	0.133182E 01	0.310511E 00
6.00	-0.661057E 01	0.189074E 00	0.133765E 01	0.266346E 00
5.00	-0.660565E 01	0.157670E 00	0.134258E 01	0.222091E 00
4.00	-0.660164E 01	0.126207E 00	0.134661E 01	0.177762E 00
3.00	-0.659851E 01	0.946967E-01	0.134975E 01	0.133374E 00
2.00	-0.659628E 01	0.631508E-01	0.135199E 01	0.889405E-01
1.00	-0.659494E 01	0.315814E-01	0.135334E 01	0.444777E-01
0.00	-0.659449E 01	0.000000E 00	0.135378E 01	0.000000E 00

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Y	HORIZONTAL VELOCITY	VERTICAL VELOCITY	HORIZONTAL ACCELERATION	VERTICAL ACCELERATION
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40.00	-0.769916E 01	0.000000E 00	0.000000E 00	0.130230E 01
39.00	-0.767104E 01	0.000000E 00	0.000000E 00	0.127706E 01
38.00	-0.764363E 01	0.000000E 00	0.000000E 00	0.125127E 01
37.00	-0.761693E 01	0.000000E 00	0.000000E 00	0.122494E 01
36.00	-0.759094E 01	0.000000E 00	0.000000E 00	0.119808E 01
35.00	-0.756567E 01	0.000000E 00	0.000000E 00	0.117071E 01
34.00	-0.754111E 01	0.000000E 00	0.000000E 00	0.114283E 01
33.00	-0.751726E 01	0.000000E 00	0.000000E 00	0.111447E 01
32.00	-0.749412E 01	0.000000E 00	0.000000E 00	0.108565E 01
31.00	-0.747169E 01	0.000000E 00	0.000000E 00	0.105636E 01
30.00	-0.744998E 01	0.000000E 00	0.000000E 00	0.102664E 01
29.00	-0.742898E 01	0.000000E 00	0.000000E 00	0.996480E 00
28.00	-0.740869E 01	0.000000E 00	0.000000E 00	0.965913E 00
27.00	-0.738911E 01	0.000000E 00	0.000000E 00	0.934945E 00
26.00	-0.737024E 01	0.000000E 00	0.000000E 00	0.903592E 00
25.00	-0.735209E 01	0.000000E 00	0.000000E 00	0.871869E 00
24.00	-0.733465E 01	0.000000E 00	0.000000E 00	0.839790E 00
23.00	-0.731792E 01	0.000000E 00	0.000000E 00	0.807368E 00
22.00	-0.730190E 01	0.000000E 00	0.000000E 00	0.774618E 00
21.00	-0.728659E 01	0.000000E 00	0.000000E 00	0.741554E 00
20.00	-0.727199E 01	0.000000E 00	0.000000E 00	0.708191E 00
19.00	-0.725811E 01	0.000000E 00	0.000000E 00	0.674542E 00
18.00	-0.724494E 01	0.000000E 00	0.000000E 00	0.640623E 00
17.00	-0.723248E 01	0.000000E 00	0.000000E 00	0.606447E 00
16.00	-0.722073E 01	0.000000E 00	0.000000E 00	0.572029E 00
15.00	-0.720970E 01	0.000000E 00	0.000000E 00	0.537382E 00
14.00	-0.719938E 01	0.000000E 00	0.000000E 00	0.502521E 00
13.00	-0.718977E 01	0.000000E 00	0.000000E 00	0.467461E 00
12.00	-0.718087E 01	0.000000E 00	0.000000E 00	0.432216E 00
11.00	-0.717268E 01	0.000000E 00	0.000000E 00	0.396799E 00
10.00	-0.716520E 01	0.000000E 00	0.000000E 00	0.361225E 00
9.00	-0.715844E 01	0.000000E 00	0.000000E 00	0.325509E 00
8.00	-0.715239E 01	0.000000E 00	0.000000E 00	0.289665E 00
7.00	-0.714705E 01	0.000000E 00	0.000000E 00	0.253706E 00
6.00	-0.714242E 01	0.000000E 00	0.000000E 00	0.217648E 00
5.00	-0.713851E 01	0.000000E 00	0.000000E 00	0.181504E 00
4.00	-0.713530E 01	0.000000E 00	0.000000E 00	0.145289E 00
3.00	-0.713281E 01	0.000000E 00	0.000000E 00	0.109016E 00
2.00	-0.713103E 01	0.000000E 00	0.000000E 00	0.727014E-01
1.00	-0.712996E 01	0.000000E 00	0.000000E 00	0.363578E-01
0.00	-0.712961E 01	0.000000E 00	0.000000E 00	0.000000E 00

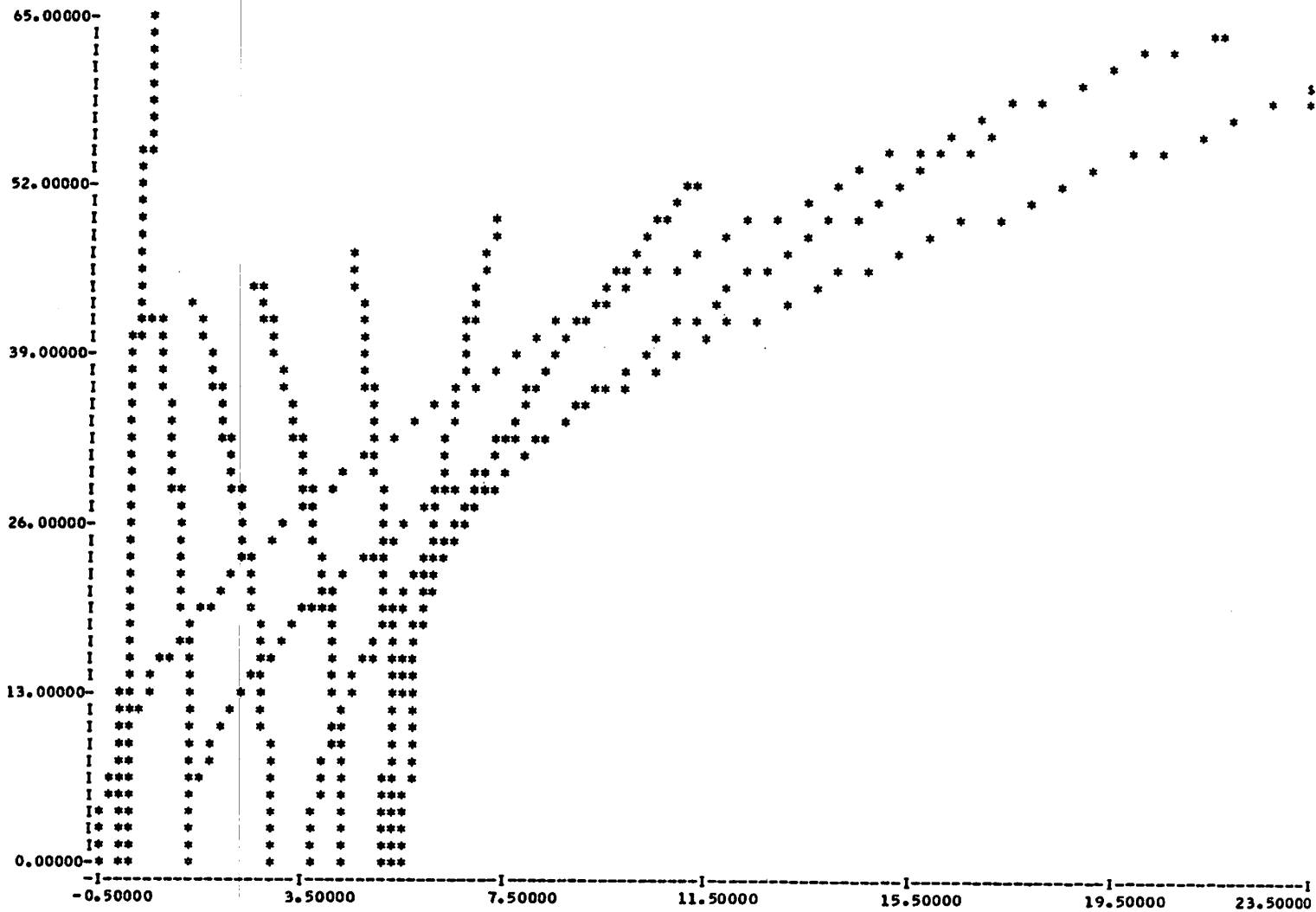


HORIZONTAL AXIS - HORIZ. VELOCITIES  
 VERTICAL AXIS - DEPTH  
 HORIZ. VELOCITIES  
 VERSUS DEPTH



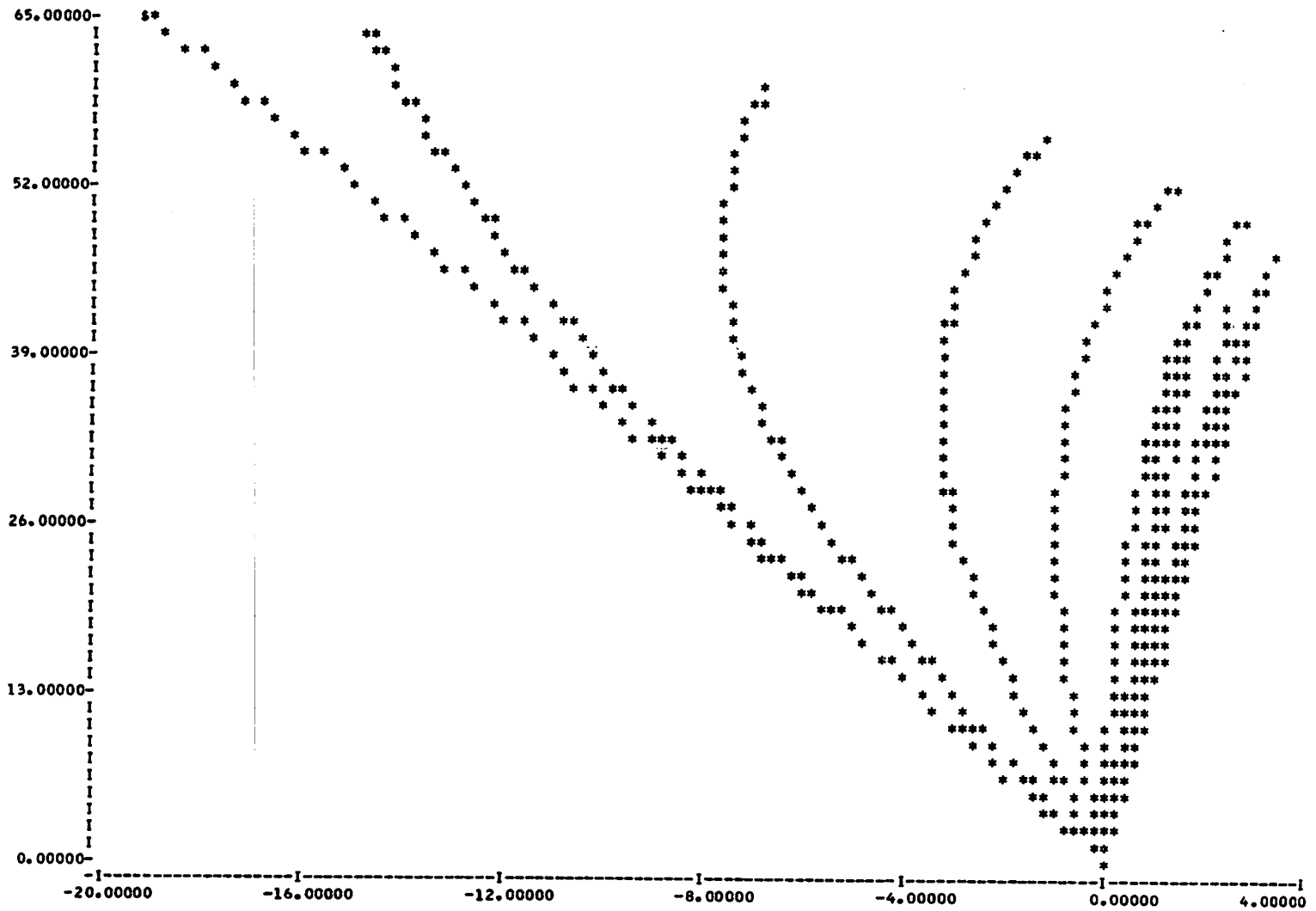
HORIZONTAL AXIS - VERTICAL VELOCITIES  
 VERTICAL AXIS - DEPTH

VERTICAL VELOCITIES  
 VERSUS DEPTH



HORIZONTAL AXIS - HORIZ. ACCELERATIONS  
 VERTICAL AXIS - DEPTH

HORI. ACCELERATIONS  
 VERSUS DEPTH



HORIZONTAL AXIS - VERT. ACCELERATIONS  
 VERTICAL AXIS - DEPTH

VERT. ACCELERATIONS  
 VERSUS DEPTH

65.00000-  
60.00000-  
55.00000-  
50.00000-  
45.00000-  
40.00000-

0.00000 0.09000 0.18000 0.27000 0.36000 0.45000 0.54000

HORIZONTAL AXIS - WATER SURFACE  
VERTICAL AXIS - HORIZONTAL DISTANCE  
SURFACE PROFILE

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CORE USAGE      OBJECT CODE= 20272 BYTES, ARRAY AREA= 47808 BYTES, TOTAL AREA AVAILABLE= 145504 BYTES  
COMPILE TIME= 2.59 SEC, EXECUTION TIME= 13.13 SEC, TAMU/WATFIV - VER 1 LEV 2 AUGUST 1970      DATE= 71/140



#### IV. WAVE FORCES AND MOMENTS ON CIRCULAR CYLINDRICAL PILES BY SMALL AMPLITUDE WAVE THEORY

Forces and moments on a pile are computed by this program using the small amplitude wave theory. The wave length is calculated to an accuracy of two decimal places using an iterative process. The deep water wave length is determined for an initial trial, then the actual wave length is approached as can be seen below from an example run.

<u>Trial Wave Length</u>	<u>Calculated Wave Length</u>
1152.00	573.17
862.58	717.32
789.95	762.70
776.33	771.67
774.00	773.22
773.61	773.48
773.54	773.52
773.53	773.53

The point along the wave where the maximum force occurs will be  $-T/4 < t < 0$ . Since the exact position is unknown, forces and moments are calculated for every two degrees starting at  $-T/4$ . The equation determining the total forces exerted on the pile is given by

$$F_T = \frac{\gamma C_D D a^2}{2} \cdot \frac{kh \cos(\sigma t) |\cos(\sigma t)|}{\sinh(zkh)} \cdot \left\{ \frac{1}{2kh} \sinh[2kh(1 + \frac{n}{h})] + (1 + \frac{n}{h}) \right\} \\ - \frac{\gamma C_I \pi D^2}{4} \frac{a \sin(\sigma t)}{\cosh(kh)} \{ \sinh [kh(k + \frac{n}{h})] \}$$

where

$\gamma$  = specific weight of the water

$C_D$  = drag coefficient

$a$  = wave amplitude

$h$  = water depth

$t$  = distance in time

$\eta$  = distance from SWE

$C_I$  = inertia or mass coefficient

$D$  = pile diameter

$k = 2\pi/L$

$L$  = wave length

$\sigma = 2\pi/T$

$T$  = wave period

The total moment acting on the pile is given by

$$M_T = \frac{\gamma C_D D}{2} \frac{a^2 h k \cos(\sigma t) |\cos(\sigma t)|}{\sinh(2kh)} \cdot \left\{ \frac{(1 + \frac{\eta}{h})}{2} \sinh [2kh(1 + \frac{\eta}{h})] \right. \\ + \frac{1}{(2kh)^2} [1 - \cosh [2kh(1 + \frac{\eta}{h})]] \\ - \frac{\gamma C_I \pi D^2}{4} \frac{ah \sin(\sigma t)}{\cosh(kh)} (1 + \frac{\eta}{h}) \sinh [kh(1 + \frac{\eta}{h})] \\ \left. + \frac{1}{kh} [1 - \cosh [kh(1 + \frac{\eta}{h})]] \right\}$$

After solution of these equations at every point for  $-T/4 < t < 0$ , the location of and magnitude of the forces and moments can be found in the computer output.

C THIS PROGRAM COMPUTES FORCES AND MOMENTS ON A PILE USING THE  
 C SMALL AMPLITUDE WAVE THEORY

C T=WAVE PERIOD  
 C H=WAVE HEIGHT  
 C D=WATER DEPTH  
 C PD=PILE DIAMETER  
 C CI=INERTIA COEFFICIENT  
 C CD=DRAG COEFFICIENT  
 C FMAX AND TMAX=0.0  
 C TH=NUMBER OF DEGREES FROM WAVE CREST  
 C FT1=DRAG FORCE  
 C FT2=INERTIA FORCE  
 C T1=DRAG MOMENT  
 C T2=INERTIA MOMENT  
 C FT=TOTAL FORCE  
 C T=TOTAL MOMENT

```

1 READ(5,100)T,H,D,PD,CD,CI,FMAX,TMAX
2 W=64.0
3 G=32.2
4 PI=3.1416
5 WL=5.12*T*T
6 10 X=2.*PI*D/WL
7 WLT= G*T*T*TANH(X)/(2.*PI)
8 DIFF=WL-WLT
9 WRITE(6,200)WL,WLT
10 WL=(WL+WLT)/2.
11 IF(ABS(DIFF).GT.0.01) GO TO 10
12 A=H/2
13 TH=-92.
14 CK=2.*PI/WL
15 WRITE(6,600)WL,H,D,T,PD,CD,CI
16 600 FORMAT(1H1,///,T51,'SMALL AMPLITUDE WAVE THEORY',///,T49,'ALL UNIT
1S IN FEET, POUNDS, SECONDS',///,T50,'WAVELENGTH =' ,F16.2,///,T50,
2' WAVE HEIGHT =' ,F15.2,///,T50,'WATER DEPTH =' ,F15.2,///,T50,
3' WAVE PERIOD =' ,F15.2,///,T50,'PILE DIAMETER =' ,F14.2,///,T50,
4' CD =' ,F24.2,///,T50,'CI =' ,F24.2)
17 WRITE(6,300)
18 C1=W*CD*PD*A*A*CK*D/(2.*SINH(2.*CK*D))
19 C2=W*CI*PI*PD*PD*A/(4.*COSH(CK*D))
20 DO 20 KK=1,46
21 TH=TH+2.
22 R=TH/57.29578
23 E=A*COS(R)
24 FT1=C1*COS(R)*ABS(COS(R))*((SINH(2.*CK*D*(1.+E/D)))/(2.*CK*D))+(1.+
1E/D))
25 FT2=C2*SIN(R)*(SINH(CK*D*(1.+E/H)))
26 FT=FT1-FT2
27 T1=C1*D*COS(R)*ABS(COS(R))*((1.+E/D)**2./2.+((1.+E/D)/(2.*CK*D))*S
1INH(2.*CK*D*(1.+E/D))+1.-COSH(2.*CK*D*(1.+E/D)))/(4.*CK*CK*D*D)
28 T2=C2*D*SIN(R)*((1.+E/D)*SINH(CK*D*(1.+E/D))+1.-COSH(CK*D*(1.+E/D
1)))/(CK*D)
29 T=T1-T2
30 IF(FT.GT.FMAX)FMAX=FT
31 IF(T.GT.TMAX)TMAX=T
32 20 WRITE(6,400)TH,FT1,FT2,T1,T2,FT,T
33 WRITE(6,500)FMAX,TMAX
34 100 FORMAT(8F10.4)
    
```

```
35 200 FORMAT(2E16.8)
36 300 FORMAT(1H1,///,T10,'DEGREES',T21,'DRAG FORCE',T36,'INERTIA FORCE'
    1,T53,'DRAG MOMENT',T67,'INTERIA MOMENT',T85,'TOTAL FORCE',
    2T100,'TOTAL MOMENT',//)
37 400 FORMAT(T10,F7.2,6E16.7)
38 500 FORMAT(///,10X,'** MAXIMUM FORCE =',E16.8,/,10X,'** MAXIMUM MOME
    INT =',E16.8)
39 STOP
40 END
```

//\$DATA

```
0.11519990E 04 0.57316670E 03
0.86258320E 03 0.71732200E 03
0.78995260E 03 0.76270210E 03
0.77632730E 03 0.77167260E 03
0.77400000E 03 0.77321940E 03
0.77360960E 03 0.77347920E 03
0.77354440E 03 0.77352290E 03
0.77353360E 03 0.77352970E 03
```

SMALL AMPLITUDE WAVE THEORY

ALL UNITS IN FEET, POUNDS, SECONDS

WAVELENGTH = 773.53

WAVE HEIGHT = 30.00

WATER DEPTH = 100.00

WAVE PERIOD = 15.00

PILE DIAMETER = 4.00

CD = 1.05

CI = 1.40

DEGREES	DRAG FORCE	INERTIA FORCE	DRAG MOMENT	INTERIA MOMENT	TOTAL FORCE	TOTAL MOMENT
-90.00	0.2482181E-08	-0.1133001E 05	0.1370805E-06	-0.5957216E 06	0.1133001E 05	0.5957216E 06
-88.00	0.3091348E 02	-0.1156349E 05	0.1717768E 04	-0.6025646E 06	0.1159440E 05	0.6042824E 06
-86.00	0.1244417E 03	-0.1178432E 05	0.6957316E 04	-0.6087056E 06	0.1190877E 05	0.6156629E 06
-84.00	0.2815466E 03	-0.1199138E 05	0.1583690E 05	-0.6141116E 06	0.1227292E 05	0.6299485E 06
-82.00	0.5028623E 03	-0.1218353E 05	0.2845723E 05	-0.6187457E 06	0.1268639E 05	0.6472029E 06
-80.00	0.7887053E 03	-0.1235962E 05	0.4490124E 05	-0.6225764E 06	0.1314832E 05	0.6674776E 06
-78.00	0.1139053E 04	-0.1251858E 05	0.6523222E 05	-0.6255721E 06	0.1365763E 05	0.6908043E 06
-76.00	0.1535542E 04	-0.1265929E 05	0.8949269E 05	-0.6277034E 06	0.1421282E 05	0.7171961E 06
-74.00	0.2031415E 04	-0.1278066E 05	0.1177004E 06	-0.6289363E 06	0.1481207E 05	0.7466366E 06
-72.00	0.2571586E 04	-0.1288165E 05	0.1498514E 06	-0.6292447E 06	0.1545323E 05	0.7790961E 06
-70.00	0.3172589E 04	-0.1296125E 05	0.1859162E 06	-0.6286044E 06	0.1613383E 05	0.8145206E 06
-68.00	0.3832587E 04	-0.1301845E 05	0.2258397E 06	-0.6269849E 06	0.1685104E 05	0.8528246E 06
-66.00	0.4549395E 04	-0.1305236E 05	0.2695408E 06	-0.6243679E 06	0.1760175E 05	0.8939087E 06
-64.00	0.5320402E 04	-0.1306208E 05	0.3169083E 06	-0.6207311E 06	0.1838248E 05	0.9376394E 06
-62.00	0.6142711E 04	-0.1304677E 05	0.3678076E 06	-0.6160557E 06	0.1918948E 05	0.9838633E 06
-60.00	0.7013027E 04	-0.1300571E 05	0.4220748E 06	-0.6103275E 06	0.2001874E 05	0.1032402E 07
-58.00	0.7927738E 04	-0.1293818E 05	0.4795173E 06	-0.6035306E 06	0.2086592E 05	0.1083047E 07
-56.00	0.8882898E 04	-0.1284362E 05	0.5399172E 06	-0.5956551E 06	0.2172652E 05	0.1135572E 07
-54.00	0.9874254E 04	-0.1272146E 05	0.6030306E 06	-0.5866958E 06	0.2259571E 05	0.1189726E 07
-52.00	0.1089727E 05	-0.1257128E 05	0.6685869E 06	-0.5766465E 06	0.2346855E 05	0.1245233E 07
-50.00	0.1194712E 05	-0.1239277E 05	0.7362895E 06	-0.5655054E 06	0.2433989E 05	0.1301794E 07
-48.00	0.1301880E 05	-0.1218567E 05	0.8058249E 06	-0.5532769E 06	0.2520447E 05	0.1359101E 07
-46.00	0.1410701E 05	-0.1194986E 05	0.8768511E 06	-0.5399663E 06	0.2605687E 05	0.1416817E 07
-44.00	0.1520632E 05	-0.1168530E 05	0.9490106E 06	-0.5255830E 06	0.2689163E 05	0.1474593E 07
-42.00	0.1631113E 05	-0.1139207E 05	0.1021928E 07	-0.5101370E 06	0.2770320E 05	0.1532064E 07
-40.00	0.1741573E 05	-0.1107041E 05	0.1095215E 07	-0.4936481E 06	0.2848614E 05	0.1588863E 07
-38.00	0.1851431E 05	-0.1072063E 05	0.1168469E 07	-0.4761344E 06	0.2923494E 05	0.1644603E 07
-36.00	0.1960101E 05	-0.1034314E 05	0.1241278E 07	-0.4576199E 06	0.2994416E 05	0.1698897E 07
-34.00	0.2067002E 05	-0.9938543E 04	0.1313227E 07	-0.4381332E 06	0.3060856E 05	0.1751360E 07
-32.00	0.2171543E 05	-0.9507508E 04	0.1383893E 07	-0.4177024E 06	0.3122293E 05	0.1801595E 07
-30.00	0.2273155E 05	-0.9050836E 04	0.1452858E 07	-0.3963653E 06	0.3178239E 05	0.1849223E 07
-28.00	0.2371264E 05	-0.8569438E 04	0.1519701E 07	-0.3741568E 06	0.3228208E 05	0.1893857E 07
-26.00	0.2465330E 05	-0.8064367E 04	0.1584018E 07	-0.3511181E 06	0.3271767E 05	0.1935136E 07
-24.00	0.2554810E 05	-0.7536785E 04	0.1645403E 07	-0.3272958E 06	0.3308488E 05	0.1972698E 07
-22.00	0.2639194E 05	-0.6987938E 04	0.1703473E 07	-0.3027349E 06	0.3337988E 05	0.2006207E 07
-20.00	0.2717998E 05	-0.6419184E 04	0.1757855E 07	-0.2774872E 06	0.3359917E 05	0.2035342E 07
-18.00	0.2790770E 05	-0.5832016E 04	0.1808206E 07	-0.2516059E 06	0.3373972E 05	0.2059811E 07
-16.00	0.2857082E 05	-0.5227961E 04	0.1854193E 07	-0.2251458E 06	0.3379879E 05	0.2079338E 07
-14.00	0.2916547E 05	-0.4608699E 04	0.1895518E 07	-0.1981654E 06	0.3377417E 05	0.2093683E 07
-12.00	0.2968816E 05	-0.3975930E 04	0.1931905E 07	-0.1707253E 06	0.3366409E 05	0.2102630E 07
-10.00	0.3013575E 05	-0.3331451E 04	0.1963115E 07	-0.1428868E 06	0.3346720E 05	0.2106001E 07
-8.00	0.3050570E 05	-0.2677121E 04	0.1988943E 07	-0.1147142E 06	0.3318282E 05	0.2103657E 07
-6.00	0.3079572E 05	-0.2014849E 04	0.2009213E 07	-0.8627256E 05	0.3281057E 05	0.2095485E 07
-4.00	0.3100416E 05	-0.1346578E 04	0.2023793E 07	-0.5762823E 05	0.3235074E 05	0.2081421E 07
-2.00	0.3112967E 05	-0.6742961E 03	0.2032578E 07	-0.2884814E 05	0.3180396E 05	0.2061426E 07
0.00	0.3117163E 05	0.0000000E 00	0.2035514E 07	0.0000000E 00	0.3117163E 05	0.2035514E 07

\*\* MAXIMUM FORCE = 0.33798780E 05

\*\* MAXIMUM MOMENT = 0.21060010E 07

CORE USAGE      OBJECT CODE=      4672 BYTES,ARRAY AREA=      0 BYTES,TOTAL AREA AVAILABLE=      133216 BYTES

## V. A COMBINED EFFECT OF REFRACTION AND DIFFRACTION OF WATER WAVES

### 1. General Description

The REDSEA program is a combination of a refraction program written by Orr and Herbich<sup>2</sup> and a diffraction program by Fan<sup>1</sup>. The main program consists of the refraction program while the revised diffraction program is incorporated in subroutine DIFFR. In the simplest terms, the technique used in REDSEA is to initiate orthogonals as in the refraction program. Then as each point along an orthogonal is located, the refraction and shoaling coefficients are calculated. Following this the coordinates of the point are transformed into coordinates used in the diffraction coefficient calculations, and a wave length at that point is calculated according to the relationship

$$L = CT$$

With this information a diffraction coefficient is calculated and the wave height at that point becomes the product of the shoaling, refraction, and diffraction coefficients. A wave orthogonal is terminated when it reaches the breakwater, the limits of the grid, or the shore. The orthogonals thus plotted are termed "primary" orthogonals for future reference.

Once all of the primary orthogonals have been plotted, the computer program initiates a second series of orthogonals in the lee of the breakwater, which will be termed "radial" orthogonals.

The orthogonals of this series all start at the breakwater tip but differ from each other in the direction each takes initially. This direction is established by the program itself which assigns the first radial orthogonal a direction fifteen degrees clockwise from the breakwater line. Each successive radial orthogonal is assigned an initial direction fifteen degrees clockwise from the preceding one, and the initiation of radial orthogonals is continued until finally an orthogonal is propagated out of the lee of the breakwater, at which point the problem is stopped.

Several problems are encountered in implementing the basic plan for REDSEA however. First, in order to calculate a diffraction coefficient, the angle between the wave orthogonal and the breakwater must be known, and yet if refraction takes place between the orthogonal origin and the breakwater, the angle will not be known until the orthogonal is propagated to the breakwater. To overcome this problem, an approximation is made in REDSEA. For all of the primary orthogonals, the angle between the breakwater and the wave orthogonal is taken as the value of that angle at the orthogonal origin. In other words, any change in direction due to refraction between the origin and the breakwater is neglected. The error introduced by making this assumption is small since diffraction coefficient will generally be near unity except in the lee of the breakwater, and a small variation in the angle of incidence will have little effect. However in the lee of the breakwater, this angle is very important, and for this reason the assumption is not carried on to the radial orthogonals. Instead, the wave angle of the last orthogonal passing the breakwater tip is taken as the angle of incidence for the purpose of calculating the diffraction coefficients in the lee of the breakwater. A similar problem is encountered in calculating the wave height in the protected zone, for if the wave height was changed by refraction before a wave reached the breakwater tip, then this change would influence the wave height in the lee. Since the radial orthogonals are initiated at the tip of the breakwater with an initial refraction coefficient of unity, any changes that might have previously occurred in the height would not be accounted for unless specific provision were made. In this case the refraction coefficient of the last orthogonal passing the breakwater is recorded, and all wave heights in the breakwater lee are increased or decreased in proportion to this value.

REDSEA was written with as few limitations as possible within the established framework, and has been used to simulate conditions in a 6 ft x 12 ft wave tank, as well as a bay half a mile wide.



The REDSEA program produced information which is divided into two sections. The first section is a recapitulation of the water depth data as it was recorded within the computer, and it is included in the data printout primarily to facilitate the detection of any errors in this information. The second section is a detailed account of the REDSEA prediction for the conditions given, and is self-explanatory. It should be noted that as many problems as are desired may be run at one time by adding a separate problem data card for each set of wave conditions following the Water Depth Cards.

Further description of the program may be obtained from the Sea Grant Publication by Worthington and Herbich.<sup>3</sup>

*Example of one Use of REDSEA Computer Program*

- Given:**
- a) Wave tank bottom topography (reproduced in a computer solution)
  - b) Breakwater extending from coordinates (9.3, 5.0) to (25.0, 5.0)
  - c) Wave period,  $T = 1.28$  sec
  - d) Angle of wave incidence with depth grid =  $90^\circ$
  - e) Coefficient of reflection from breakwater = 22%

- Required:**
- a) Wave height and direction at coordinates (12.0, 8.0)
  - b) Wave height and direction at coordinates (12.0, 8.0) if breakwater wave extended 5 feet

**Solution:** Using REDSEA program, specify:

Number of horiz grid points,  $M = 25$

Number of vert grid points,  $N = 25$

Number of problems,  $NOP = 2$

Grid line spacing,  $SP$  (ft) = 1

Enter water depths in feet

} Card 1

} Cards 2-626

Wave angle with respect to horiz grid (degrees), ALPHL(2)	= 90.0	
Wave period, T(sec)	= 1.28	
Orthogonal point time increment, DELT (sec)	= 0.25	
Initial orth origin (horiz grid coord) X(1)	= 6.0	
Initial orth origin (vert grid coord) Y(1)	= 2.0	
Orth origin limit (Horiz grid coord), GM	= 10.1	} Card 627
Dist between orth (grid spacings), UK	= 0.5	
Breakwater tip (horiz coord), BWTX	= 9.3	
Breakwater tip (vert coord), BWTY	= 5.0	
Breakwater butt (horiz coord), BWBX	= 25.0	
Breakwater butt (vert coord), BWBY	= 5.0	
Reflection from breakwater (% ÷ 100)	= 0.22	

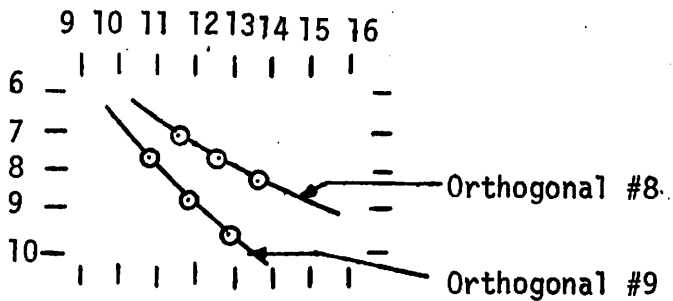
Card 628 will be identical to 627 except that

Initial orth origin (horizon grid coord) x(1)	= 3.0	} Card 628
Orth origin limit (horiz grid coord) QM)	= 6.1	
Breakwater tip (horiz coord) BWTX	= 4.3	

From attached computer run:

- (a) Problem 1, orthogonal 8 plot points 3, 4 & 5
- orthogonal 9 plot points 3, 4 & 5

which are the points closest to the area of interest



The point of interest is seen to lie approximately midway between point 8-4 and point 9-4, and the wave parameters will be estimated by averaging the values for these two points.

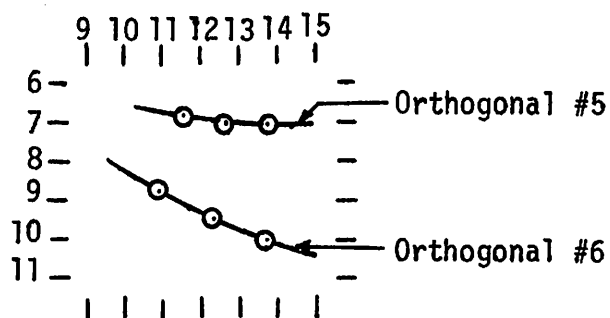
Hence

$$\frac{H}{H_0} = \frac{.18 + .21}{2} = .195$$

$$\text{Direction} = \frac{28.56 + 46.29}{2} \approx$$

Note: Since the incident wave ( $H_I$ ) is not a "deep water" wave ( $H_0$ ) the value of  $H/H_I$  will be different from  $H/H_0$ . The ratio of  $H_I/H_0$  is identical to the shoaling coefficient of the incident wave which is .93 (from Orthogonal 1)

(b) Problem 2, orthogonal 5, points 6, 7 & 8  
orthogonal 6, points 6, 7 & 8



Average parameters between points 5-7 and 6-7

$$\frac{H}{H_0} = \frac{.13 + .12}{2} = .125$$

$$\text{Direction} = \frac{5.13 + 25.02}{2} \approx 27^\circ$$

Summary

	<u>Present Breakwater</u>	<u>Extended Breakwater</u>
Height Coef ( $H/H_0$ )	.195	.125
Direction (degrees)	37°	27°

## 8. Bibliography

1. Fan, S., J. E. Cumming, and R. L. Wiegel, "Computer Solution of Wave Diffraction by Semi-Infinite Breakwater", HEL 1-8, University of California, Berkeley, 1967.
2. Orr, T. E., and J. B. Herbich, "Numerical Calculation of Wave Diffraction by Digital Computer", Sea Grant Publication Number 209, Texas A&M University, 1969.
3. Worthington, H. W., and Herbich, J. B., "A Computer Program to Estimate the Combined Effect of Refraction and Diffraction of Water Waves", Sea Grant Publication Number 219, Texas A&M University, 1970.



12	30 FORMAT (12F5.3)	REDSEA
	C DEFINE VARIABLES	REDSEA
13	G=32.17398	REDSEA
14	PI=3.141592654	REDSEA
15	RSW=0	REDSEA
16	A=(G*TH)/(6.28*SP)	REDSEA
17	B=(6.28/TH)	REDSEA
	C PRINT DATA, CONDITIONS, AND HEADINGS	REDSEA
18	IF (IGO.NE.1) GO TO 888	REDSEA
19	WRITE (6,38) M,N,NOP,SP	REDSEA
20	38 FORMAT (1H1,2X,'WATER DEPTH DATA',///,3X,'NUMBER OF HORIZONTAL GRID LINES', I6,///,3X,'NUMBER OF VERTICAL GRID LINES ',2X,I5,///3X,'NUMBER OF PROBLEMS ',13X,I5,///,3X,'GRID INTERVAL',19X,F5.1,1X,'FT' 3,///,57X,'D E P T H S O U N D I N G S')	REDSEA
21	WRITE (6,29) ((D(I,J),I=1,M),J=1,N)	REDSEA
22	29 FORMAT(1H,///,3X,25F5.2)	REDSEA
23	888 WRITE (6,33) IGO,ALPH(2),TH,DELT,X(1),Y(1),QM,UK,BWTX,BWY,BWBX,BWBY,CRFL	REDSEA
24	33 FORMAT (1H1,2X,'PROBLEM DATA',///,2X,'PROBLEM NUMBER',16X,I5,///,2X,'ANGLE OF INCIDENCE',12X,F7.2,1X,'DEGREES',///,2X,'WAVE PERIOD',219X,F7.2,1X,'SECONDS',//,2X,'TIME INCREMENT',16X,F7.2,1X,'SECONDS 3'//,2X,'INITIAL ORTHOGONAL ORIGIN' 5X,2F7.1,1X,'(HORIZ,VERT)', 4 //, 2X, 'MAX HORIZ ORTHOGONAL ORIGIN' , 3X, F7.1, //, 2X, 'ORTHOGONAL ORIGIN INTERVAL 6', 4X, F7.1, //, 2X, 'BREAKWATER TIP', 15X, 2F7.1,1X, '(HORIZ, VE 7RT)' //, 2X, 'BREAKWATER BUTT', 15X, 2F7.1,1X,'(HORIZ,VERT)', 8//,2X,'COEFFICIENT OF REFLECTION',/,4X, 'FROM BREAKWATER',13X,F7.2 9)	REDSEA
	C CALCULATE BREAKWATER ANGLE W/ HORIZ GRID	REDSEA
25	ALPH (2)=(PI*ALPH(2))/180.0	REDSEA
26	BWDX=BWBX-BWTX	REDSEA
27	BWDY=BWY-BWBY	REDSEA
28	BWANG=ATAN2(BWDY,BWDX)	REDSEA
	C CALCULATE WAVE ANGLE FOR DIFFRACTION COORD SYSTEM	REDSEA
29	MWANG=ALPH(2)+BWANG	REDSEA
30	IP=0	REDSEA
	C CALCULATE CELERITY	REDSEA
31	I=1	REDSEA
32	15 J=1	REDSEA
33	PO=A	REDSEA
34	47 IF(IGO.EQ. 1) GO TO 14	REDSEA
	C RECORD DEPTH IN GRID SPACING UNITS	REDSEA
35	D(I,J)=D(I,J)*SP	REDSEA
36	14 IF (D(I,J)-0.03*SP) 11,11,922	REDSEA
37	922 D(I,J)=D(I,J)/SP	REDSEA
38	13 P1=A*TANH((B*D(I,J))/PO)	REDSEA
39	IF(ABS(P1-PO)-(0.001*PO).LE.0.0) GO TO 12	REDSEA
40	PO=P1	REDSEA
41	GO TO 13	REDSEA
42	12 C(I,J)=P1	REDSEA
43	PO=P1	REDSEA
44	GO TO 34	REDSEA
45	11 C(I,J)=0.0	REDSEA
46	D(I,J)=D(I,J)/SP	REDSEA
47	34 J=J+1	REDSEA
48	IF ((N-J).GE.0) GO TO 47	REDSEA
49	I=I+1	REDSEA
50	IF ((M-I).GE.0) GO TO 15	REDSEA
	C CALCULATE CELERITY DERIVATIVES	REDSEA
51	I=2	REDSEA
52	19 J=2	REDSEA











241

END

C

//SDATA

REDSEA  
REDSEA

WATER DEPTH DATA

NUMBER OF HORIZONTAL GRID LINES 25  
NUMBER OF VERTICAL GRID LINES 25  
NUMBER OF PROBLEMS 2  
GRID INTERVAL 1.0 FT

DEPTH SOUNDINGS

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2.00 2.00 2.00 2.00 2.00 2.00 2.00 2.00 2.00 1.80 1.40 1.00 0.62 0.62 0.62 0.62 0.62 0.62 0.62 0.62 0.62 0.62 0.62 0.62  
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2.00 2.00 2.00 2.00 2.00 2.00 2.00 2.00 2.00 1.80 1.40 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00  
2.00 2.00 2.00 2.00 2.00 2.00 2.00 2.00 2.00 1.80 1.35 1.35 1.35 1.35 1.35 1.35 1.35 1.35 1.35 1.35 1.35 1.35 1.35 1.35  
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PROBLEM DATA

PROBLEM NUMBER 1  
 ANGLE OF INCIDENCE 90.00 DEGREES  
 WAVE PERIOD 1.28 SECONDS  
 TIME INCREMENT 0.25 SECONDS  
 INITIAL ORTHOGONAL ORIGIN 6.0 2.0 (HORIZ,VERT)  
 MAX HORIZ ORTHOGONAL ORIGIN 10.1  
 ORTHOGONAL ORIGIN INTERVAL 1.0  
 BREAKWATER TIP 9.3 5.0 (HORIZ, VERT)  
 BREAKWATER BUTT 25.0 5.0 (HORIZ,VERT)  
 COEFFICIENT OF REFLECTION FROM BREAKWATER 0.22

ORTHGNL NUMBER	POINT NUMBER	TIME (SEC)	COORDINATES X Y		DEPTH (FT)	REFRACTION COEF	SHOALING COEF	DIFFFRACTION COEF	HEIGHT COEF	WAVE DIRECTION
1	1	0.00	6.0	2.0	ORTHOAGONAL	ORIGIN				
	2	0.25	6.0	3.5	2.00	1.00	0.93	0.99	0.92	90.00
	3	0.50	6.0	5.0	2.00	1.00	0.93	1.13	1.05	90.00
	4	0.75	6.0	6.5	2.00	1.00	0.93	1.12	1.04	90.00
	5	1.00	6.0	8.1	2.00	1.00	0.93	1.04	0.97	90.00
	6	1.25	6.0	9.6	2.00	1.00	0.93	0.97	0.90	90.00
	7	1.50	6.0	11.1	2.00	1.00	0.93	0.92	0.85	90.00
	8	1.75	6.0	12.6	2.00	1.00	0.93	0.88	0.81	90.00
	9	2.00	6.0	14.1	2.00	1.00	0.93	0.84	0.78	90.00
	10	2.25	6.0	15.6	2.00	1.00	0.93	0.82	0.76	90.00
	11	2.50	6.0	17.2	2.00	1.00	0.93	0.80	0.74	90.00
	12	2.75	6.0	18.7	2.00	1.00	0.93	0.78	0.72	90.00
	13	3.00	6.0	20.2	2.00	1.00	0.93	0.76	0.71	90.00
	14	3.25	6.0	21.7	2.00	1.00	0.93	0.75	0.70	89.47
2	1	0.00	7.0	2.0	ORTHOAGONAL	ORIGIN				
	2	0.25	7.0	3.5	2.00	1.00	0.93	1.05	0.98	90.00
	3	0.50	7.0	5.0	2.00	1.00	0.93	1.12	1.04	90.00
	4	0.75	7.0	6.5	2.00	1.00	0.93	1.01	0.93	90.00
	5	1.00	7.0	8.1	2.00	1.00	0.93	0.90	0.84	90.00
	6	1.25	7.0	9.6	2.00	1.00	0.93	0.84	0.78	90.00
	7	1.50	7.0	11.1	2.00	1.00	0.93	0.79	0.73	90.00
	8	1.75	7.0	12.6	2.00	1.00	0.93	0.76	0.71	90.00
	9	2.00	7.0	14.1	2.00	1.00	0.93	0.74	0.68	90.00
	10	2.25	7.0	15.6	2.00	1.00	0.93	0.72	0.67	90.00
	11	2.50	7.0	17.2	2.00	1.00	0.93	0.70	0.65	90.00
	12	2.75	7.0	18.7	2.00	1.00	0.93	0.69	0.64	90.00
	13	3.00	7.0	20.2	2.00	1.00	0.93	0.68	0.63	89.86
	14	3.25	7.0	21.7	1.79	0.99	0.92	0.67	0.61	88.03

1	0.00	8.0	2.0	ORTHOGONAL	ORIGIN				
2	0.25	8.0	3.5	2.00	1.00	0.93	1.09	1.01	90.00
3	0.50	8.0	5.0	2.00	1.00	0.93	1.02	0.94	90.00
4	0.75	8.0	6.5	2.00	1.00	0.93	0.82	0.76	90.00
5	1.00	8.0	8.1	2.00	1.00	0.93	0.73	0.68	90.00
6	1.25	8.0	9.6	2.00	1.00	0.93	0.69	0.64	90.00
7	1.50	8.0	11.1	2.00	1.00	0.93	0.66	0.62	90.00
8	1.75	8.0	12.6	2.00	1.00	0.93	0.65	0.60	90.00
9	2.00	8.0	14.1	2.00	1.00	0.93	0.63	0.59	90.00
10	2.25	8.0	15.6	2.00	1.00	0.93	0.62	0.58	90.00
11	2.50	8.0	17.2	2.00	1.00	0.93	0.61	0.57	90.00
12	2.75	8.0	18.7	2.00	1.00	0.93	0.61	0.56	90.00
13	3.00	8.0	20.2	1.94	1.00	0.93	0.60	0.56	89.00
14	3.25	8.1	21.6	1.45	0.96	0.91	0.59	0.52	85.23

4

1	0.00	9.0	2.0	ORTHOGONAL	ORIGIN				
2	0.25	9.0	3.5	2.00	1.00	0.93	1.09	1.01	90.00
3	0.50	9.0	5.0	2.00	1.00	0.93	0.78	0.73	89.51
4	0.75	9.0	6.5	1.99	0.98	0.93	0.59	0.54	88.48
5	1.00	9.1	8.1	2.00	0.93	0.93	0.56	0.48	87.89
6	1.25	9.1	9.6	2.00	0.89	0.93	0.54	0.44	87.85
7	1.50	9.2	11.1	2.00	0.85	0.93	0.53	0.42	87.85
8	1.75	9.3	12.6	2.00	0.82	0.93	0.52	0.39	87.85
9	2.00	9.3	14.1	2.00	0.79	0.93	0.51	0.38	87.85

5

1	0.00	10.0	2.0	ORTHOGONAL	ORIGIN				
2	0.25	10.0	3.5	2.00	1.00	0.93	1.10	1.02	90.00

6

ORTHOGONALS IN LEE OF BREAKWATER  
 WAVE HT PASSING BREAKWATER TIP TAKEN AS 1.00 X DEEP WATER HEIGHT  
 WAVE ANGLE (THETA FOR DIFFRACTION) TAKEN AS 89.5 DEGREES

1	0.00	9.3	5.0	ORTHOGONAL	ORIGIN				
2	0.25	10.7	5.4	1.51	1.01	0.91	0.22	0.20	15.04
3	0.50	12.0	5.7	1.00	1.08	0.92	0.21	0.21	14.90
4	0.75	13.1	6.0	0.62	1.21	0.96	0.18	0.21	13.98
5	1.00	14.1	6.2	0.62	1.40	0.96	0.15	0.21	12.62
6	1.25	15.1	6.4	0.62	1.79	0.96	0.14	0.24	10.59
7	1.50	16.1	6.6	0.62	3.33	0.96	0.13	0.41	7.44
8	1.75	17.2	6.7	0.62	2.66	0.96	0.12	0.32	3.49
9	2.00	18.2	6.7	0.62	1.69	0.96	0.10	0.17	-0.83
10	2.25	19.2	6.7	0.62	1.41	0.96	0.11	0.15	-5.06
11	2.50	20.2	6.6	0.62	1.31	0.96	0.10	0.13	-8.72
12	2.75	21.3	6.4	0.62	1.29	0.96	0.10	0.12	-11.45
13	3.00	22.3	6.2	0.62	1.33	0.96	0.09	0.11	-12.99
14	3.25	23.3	5.9	0.62	1.39	0.96	0.08	0.11	-12.86

7

1	0.00	9.3	5.0	ORTHOGONAL	ORIGIN				
2	0.25	10.6	5.7	1.56	1.01	0.92	0.27	0.25	28.57
3	0.50	11.8	6.3	1.08	1.03	0.92	0.24	0.23	24.70
4	0.75	12.9	6.7	0.67	1.06	0.95	0.18	0.18	18.87
5	1.00	13.9	7.0	0.63	1.19	0.96	0.17	0.20	12.69
6	1.25	14.9	7.2	0.70	1.58	0.95	0.13	0.20	6.24
7	1.50	16.0	7.3	0.72	5.79	0.95	0.12	0.66	-0.64

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8	1.75	17.1	7.2	0.69	1.70	0.95	0.13	0.21	-7.46
9	2.00	18.1	7.0	0.62	1.22	0.96	0.10	0.11	-13.66
10	2.25	19.1	6.7	0.62	1.08	0.96	0.11	0.11	-18.53
11	2.50	20.1	6.3	0.62	1.03	0.96	0.10	0.10	-21.49
12	2.75	21.0	6.0	0.62	1.02	0.96	0.10	0.09	-22.18
13	3.00	22.0	5.6	0.62	1.02	0.96	0.09	0.09	-19.26
14	3.25	23.0	5.3	0.62	1.12	0.96	0.06	0.06	-11.96
15	3.50	24.0	5.2	0.62	1.61	0.96	0.08	0.12	-1.75

8

1	0.00	9.3	5.0	ORTHOGONAL	ORIGIN				
2	0.25	10.4	6.0	1.64	1.00	0.92	0.33	0.30	42.69
3	0.50	11.5	6.9	1.22	0.98	0.91	0.28	0.25	37.02
<del>4</del>	<del>0.75</del>	<del>12.5</del>	<del>7.6</del>	<del>1.03</del>	<del>0.98</del>	<del>0.92</del>	<del>0.20</del>	<del>0.18</del>	<del>28.56</del>
<del>5</del>	<del>1.00</del>	<del>13.7</del>	<del>8.1</del>	<del>1.04</del>	<del>0.99</del>	<del>0.92</del>	<del>0.19</del>	<del>0.18</del>	<del>19.21</del>
6	1.25	14.9	8.4	1.15	0.96	0.91	0.17	0.15	10.41
7	1.50	16.2	8.6	1.20	0.90	0.91	0.12	0.10	2.40
8	1.75	17.5	8.5	1.19	0.82	0.91	0.14	0.10	-5.46
9	2.00	18.8	8.3	1.11	0.73	0.92	0.11	0.07	-13.63
10	2.25	20.0	7.9	0.98	0.65	0.92	0.10	0.06	-22.26
11	2.50	21.0	7.4	0.78	0.57	0.94	0.09	0.05	-29.88
12	2.75	21.9	6.8	0.62	0.52	0.96	0.10	0.05	-35.15
13	3.00	22.8	6.2	0.62	0.52	0.96	0.08	0.04	-37.76
14	3.25	23.6	5.6	0.62	0.52	0.96	0.07	0.04	-36.12

9

1	0.00	9.3	5.0	ORTHOGONAL	ORIGIN				
2	0.25	10.1	6.3	1.76	0.99	0.92	0.39	0.35	57.46
3	0.50	10.9	7.5	1.61	0.95	0.92	0.33	0.29	52.69
<del>4</del>	<del>0.75</del>	<del>11.9</del>	<del>8.6</del>	<del>1.66</del>	<del>0.88</del>	<del>0.92</del>	<del>0.26</del>	<del>0.21</del>	<del>46.29</del>
<del>5</del>	<del>1.00</del>	<del>12.9</del>	<del>9.5</del>	<del>1.58</del>	<del>0.78</del>	<del>0.92</del>	<del>0.26</del>	<del>0.18</del>	<del>40.23</del>
6	1.25	14.1	10.4	1.84	0.71	0.92	0.23	0.15	36.37
7	1.50	15.3	11.3	2.00	0.64	0.93	0.20	0.12	34.75
8	1.75	16.5	12.2	2.00	0.58	0.93	0.18	0.10	34.33
9	2.00	17.8	13.0	2.00	0.54	0.93	0.16	0.08	34.33
10	2.25	19.0	13.9	2.00	0.50	0.93	0.16	0.07	34.33
11	2.50	20.3	14.7	2.00	0.47	0.93	0.15	0.07	34.79
12	2.75	21.5	15.6	1.82	0.44	0.92	0.13	0.05	36.54
13	3.00	22.6	16.5	1.52	0.40	0.91	0.13	0.05	39.88
14	3.25	23.6	17.4	1.20	0.37	0.91	0.12	0.04	44.76

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1	0.00	9.3	5.0	ORTHOGONAL	ORIGIN				
2	0.25	9.7	6.4	1.85	0.98	0.92	0.45	0.41	72.64
3	0.50	10.2	7.9	1.92	0.92	0.93	0.40	0.34	69.92
4	0.75	10.8	9.3	2.00	0.84	0.93	0.35	0.27	68.34
5	1.00	11.3	10.7	2.00	0.76	0.93	0.36	0.25	67.88
6	1.25	11.9	12.1	2.00	0.70	0.93	0.33	0.22	67.78
7	1.50	12.5	13.5	2.00	0.65	0.93	0.30	0.18	67.78
8	1.75	13.0	14.9	2.00	0.61	0.93	0.30	0.17	68.04
9	2.00	13.6	16.3	1.62	0.57	0.92	0.26	0.14	68.82
10	2.25	14.1	17.5	1.16	0.55	0.91	0.27	0.14	70.77
11	2.50	14.4	18.7	0.75	0.53	0.94	0.24	0.12	73.10
12	2.75	14.7	19.7	0.62	0.50	0.96	0.24	0.12	74.37
13	3.00	15.0	20.7	0.62	0.49	0.96	0.22	0.10	74.63
14	3.25	15.3	21.7	0.62	0.47	0.96	0.24	0.11	74.63
15	3.50	15.5	22.7	0.62	0.45	0.96	0.23	0.10	77.23

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PROBLEM DATA

PROBLEM NUMBER 2  
 ANGLE OF INCIDENCE 90.00 DEGREES  
 WAVE PERIOD 1.28 SECONDS  
 TIME INCREMENT 0.25 SECONDS  
 INITIAL ORTHOGONAL ORIGIN 3.0 2.0 (HORIZ,VERT)  
 MAX HORIZ ORTHOGONAL ORIGIN 6.1  
 ORTHOGONAL ORIGIN INTERVAL 1.0  
 BREAKWATER TIP 4.3 5.0 (HORIZ, VERT)  
 BREAKWATER BUTT 25.0 5.0 (HORIZ,VERT)  
 COEFFICIENT OF REFLECTION FROM BREAKWATER 0.22

ORTHGNL NUMBER	POINT NUMBER	TIME (SEC)	COORDINATES		DEPTH (FT)	REFRACTION COEF	SHOALING COEF	DIFFRACTION COEF	HEIGHT COEF	WAVE DIRECTION
			X	Y						
1	1	0.00	3.0	2.0	ORTHOAGONAL	ORIGIN				
	2	0.25	3.0	3.5	2.00	1.00	0.93	1.09	1.01	90.00
	3	0.50	3.0	5.0	2.00	1.00	0.93	1.02	0.94	90.00
	4	0.75	3.0	6.5	2.00	1.00	0.93	0.82	0.76	90.00
	5	1.00	3.0	8.1	2.00	1.00	0.93	0.73	0.68	90.00
	6	1.25	3.0	9.6	2.00	1.00	0.93	0.69	0.64	90.00
	7	1.50	3.0	11.1	2.00	1.00	0.93	0.66	0.62	90.00
	8	1.75	3.0	12.6	2.00	1.00	0.93	0.65	0.60	90.00
	9	2.00	3.0	14.1	2.00	1.00	0.93	0.63	0.59	90.00
	10	2.25	3.0	15.6	2.00	1.00	0.93	0.62	0.58	90.00
	11	2.50	3.0	17.2	2.00	1.00	0.93	0.61	0.57	90.00
	12	2.75	3.0	18.7	2.00	1.00	0.93	0.61	0.56	90.00
	13	3.00	3.0	20.2	2.00	1.00	0.93	0.60	0.56	90.00
	14	3.25	3.0	21.7	2.00	1.00	0.93	0.60	0.55	90.00
2	1	0.00	4.0	2.0	ORTHOAGONAL	ORIGIN				
	2	0.25	4.0	3.5	2.00	1.00	0.93	1.09	1.01	90.00
	3	0.50	4.0	5.0	2.00	1.00	0.93	0.78	0.73	90.00
	4	0.75	4.0	6.5	2.00	1.00	0.93	0.60	0.56	90.00
	5	1.00	4.0	8.1	2.00	1.00	0.93	0.57	0.53	90.00
	6	1.25	4.0	9.6	2.00	1.00	0.93	0.56	0.52	90.00
	7	1.50	4.0	11.1	2.00	1.00	0.93	0.55	0.51	90.00
	8	1.75	4.0	12.6	2.00	1.00	0.93	0.54	0.50	90.00
	9	2.00	4.0	14.1	2.00	1.00	0.93	0.54	0.50	90.00
	10	2.25	4.0	15.6	2.00	1.00	0.93	0.54	0.50	90.00
	11	2.50	4.0	17.2	2.00	1.00	0.93	0.53	0.50	90.00
	12	2.75	4.0	18.7	2.00	1.00	0.93	0.53	0.49	90.00
	13	3.00	4.0	20.2	2.00	1.00	0.93	0.53	0.49	90.00
	14	3.25	4.0	21.7	2.00	1.00	0.93	0.53	0.49	90.00
3	1	0.00	3.0	2.0	ORTHOAGONAL	ORIGIN				
	2	0.25	3.0	3.5	2.00	1.00	0.93	1.09	1.01	90.00
	3	0.50	3.0	5.0	2.00	1.00	0.93	1.02	0.94	90.00
	4	0.75	3.0	6.5	2.00	1.00	0.93	0.82	0.76	90.00
	5	1.00	3.0	8.1	2.00	1.00	0.93	0.73	0.68	90.00
	6	1.25	3.0	9.6	2.00	1.00	0.93	0.69	0.64	90.00
	7	1.50	3.0	11.1	2.00	1.00	0.93	0.66	0.62	90.00
	8	1.75	3.0	12.6	2.00	1.00	0.93	0.65	0.60	90.00
	9	2.00	3.0	14.1	2.00	1.00	0.93	0.63	0.59	90.00
	10	2.25	3.0	15.6	2.00	1.00	0.93	0.62	0.58	90.00
	11	2.50	3.0	17.2	2.00	1.00	0.93	0.61	0.57	90.00
	12	2.75	3.0	18.7	2.00	1.00	0.93	0.61	0.56	90.00
	13	3.00	3.0	20.2	2.00	1.00	0.93	0.60	0.56	90.00
	14	3.25	3.0	21.7	2.00	1.00	0.93	0.60	0.55	90.00

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1	0.00	5.0	2.0	ORTHOGONAL	ORIGIN				
2	0.25	5.0	3.5	2.00	1.00	0.93	1.10	1.02	90.00

4

1	0.00	6.0	2.0	ORTHOGONAL	ORIGIN				
2	0.25	6.0	3.5	2.00	1.00	0.93	1.08	1.01	90.00

5

ORTHOGONALS IN LEE OF BREAKWATER

WAVE HT PASSING BREAKWATER TIP TAKEN AS 1.00 X DEEP WATER HEIGHT  
 WAVE ANGLE (THETA) FOR DIFFRACTION TAKEN AS 90.0 DEGREES

1	0.00	4.3	5.0	ORTHOGONAL	ORIGIN				
2	0.25	5.8	5.4	2.00	1.00	0.93	0.22	0.20	15.00
3	0.50	7.3	5.8	2.00	1.00	0.93	0.23	0.21	15.00
4	0.75	8.7	6.2	2.00	1.00	0.93	0.17	0.15	14.91
5	1.00	10.2	6.5	1.73	1.00	0.92	0.17	0.16	13.91
6	1.25	11.5	6.8	1.19	1.01	0.91	0.14	0.13	10.59
7	1.50	12.7	7.0	0.74	1.07	0.94	0.12	0.12	5.13
8	1.75	13.8	7.0	0.64	1.29	0.96	0.10	0.13	-1.02
9	2.00	14.8	7.0	0.62	2.18	0.96	0.10	0.21	-7.00
10	2.25	15.8	6.8	0.62	2.11	0.96	0.08	0.17	-12.24
11	2.50	16.8	6.5	0.62	1.26	0.96	0.09	0.11	-16.15
12	2.75	17.8	6.2	0.62	1.01	0.96	0.09	0.09	-18.39
13	3.00	18.8	5.9	0.62	0.89	0.96	0.09	0.07	-18.43
14	3.25	19.8	5.6	0.62	0.81	0.96	0.08	0.06	-15.19
15	3.50	20.8	5.4	0.62	0.82	0.96	0.06	0.04	-8.44
16	3.75	21.8	5.3	0.62	0.98	0.96	0.08	0.07	0.34
17	4.00	22.8	5.4	0.62	2.06	0.96	0.06	0.12	8.95
18	4.25	23.8	5.6	0.62	1.23	0.96	0.07	0.08	15.32

6

1	0.00	4.3	5.0	ORTHOGONAL	ORIGIN				
2	0.25	5.6	5.8	2.00	1.00	0.93	0.27	0.25	30.00
3	0.50	7.0	6.5	2.00	1.00	0.93	0.26	0.24	30.00
4	0.75	8.3	7.3	2.00	1.00	0.93	0.22	0.20	29.95
5	1.00	9.6	8.0	2.00	1.00	0.93	0.17	0.16	29.52
6	1.25	10.9	8.8	1.96	0.97	0.93	0.16	0.15	28.12
7	1.50	12.2	9.4	1.79	0.90	0.92	0.14	0.12	25.02
8	1.75	13.6	10.0	1.71	0.81	0.92	0.14	0.11	20.89
9	2.00	15.0	10.5	1.85	0.73	0.92	0.13	0.09	17.46
10	2.25	16.4	10.9	1.97	0.65	0.93	0.13	0.08	15.22
11	2.50	17.9	11.3	2.00	0.58	0.93	0.12	0.07	13.85
12	2.75	19.4	11.6	2.00	0.51	0.93	0.10	0.05	13.05
13	3.00	20.8	12.0	2.00	0.46	0.93	0.10	0.04	12.75
14	3.25	22.3	12.3	2.00	0.42	0.93	0.10	0.04	12.73
15	3.50	23.8	12.6	2.00	0.39	0.93	0.08	0.03	12.72

7

1	0.00	4.3	5.0	ORTHOGONAL	ORIGIN				
2	0.25	5.4	6.1	2.00	1.00	0.93	0.33	0.31	45.00
3	0.50	6.5	7.1	2.00	1.00	0.93	0.29	0.27	45.00
4	0.75	7.5	8.2	2.00	1.00	0.93	0.23	0.22	45.00
5	1.00	8.6	9.3	2.00	1.00	0.93	0.22	0.21	45.00
6	1.25	9.7	10.4	2.00	1.00	0.93	0.21	0.19	45.00
7	1.50	10.8	11.4	2.00	1.00	0.93	0.19	0.17	45.00
8	1.75	11.8	12.5	2.00	1.00	0.93	0.18	0.17	45.00
9	2.00	12.9	13.6	2.00	1.00	0.93	0.15	0.14	45.00

10	2.25	14.0	14.6	2.00	1.00	0.93	0.17	0.15	45.35
11	2.50	15.0	15.7	1.79	0.99	0.92	0.15	0.14	46.89
12	2.75	16.0	16.8	1.42	0.96	0.91	0.15	0.13	50.01
13	3.00	16.8	17.8	1.05	0.92	0.92	0.13	0.11	54.68
14	3.25	17.4	18.8	0.69	0.87	0.95	0.12	0.10	58.95
15	3.50	17.9	19.7	0.62	0.85	0.96	0.12	0.10	61.05
16	3.75	18.4	20.6	0.62	0.82	0.96	0.11	0.09	61.45
17	4.00	18.9	21.5	0.62	0.80	0.96	0.11	0.09	61.45
18	4.25	19.4	22.4	0.62	0.78	0.96	0.12	0.09	64.51

8

1	0.00	4.3	5.0	ORTHOGONAL	ORIGIN				
2	0.25	5.1	6.3	2.00	1.00	0.93	0.39	0.36	60.00
3	0.50	5.8	7.6	2.00	1.00	0.93	0.34	0.32	60.00
4	0.75	6.6	8.9	2.00	1.00	0.93	0.28	0.26	60.00
5	1.00	7.4	10.2	2.00	1.00	0.93	0.30	0.27	60.00
6	1.25	8.1	11.6	2.00	1.00	0.93	0.27	0.25	60.00
7	1.50	8.9	12.9	2.00	1.00	0.93	0.22	0.21	60.00
8	1.75	9.6	14.2	2.00	1.00	0.93	0.25	0.23	60.00
9	2.00	10.4	15.5	2.00	1.00	0.93	0.23	0.21	60.00
10	2.25	11.2	16.8	1.96	1.00	0.93	0.21	0.19	59.71
11	2.50	11.9	18.0	1.38	0.99	0.91	0.19	0.18	58.30
12	2.75	12.6	19.1	0.78	0.99	0.94	0.18	0.17	56.40
13	3.00	13.2	20.0	0.62	1.02	0.96	0.16	0.16	55.38
14	3.25	13.7	20.8	0.62	1.03	0.96	0.16	0.16	55.37
15	3.50	14.3	21.7	0.62	1.04	0.96	0.16	0.16	55.37
16	3.75	14.9	22.5	0.62	1.05	0.96	0.15	0.16	59.63

9

1	0.00	4.3	5.0	ORTHOGONAL	ORIGIN				
2	0.25	4.7	6.5	2.00	1.00	0.93	0.46	0.42	75.00
3	0.50	5.1	7.9	2.00	1.00	0.93	0.41	0.38	75.00
4	0.75	5.5	9.4	2.00	1.00	0.93	0.37	0.34	75.00
5	1.00	5.9	10.9	2.00	1.00	0.93	0.38	0.35	75.00
6	1.25	6.3	12.3	2.00	1.00	0.93	0.36	0.34	75.00
7	1.50	6.7	13.8	2.00	1.00	0.93	0.34	0.32	75.00
8	1.75	7.1	15.2	2.00	1.00	0.93	0.34	0.31	75.00
9	2.00	7.5	16.7	2.00	1.00	0.93	0.31	0.29	75.00
10	2.25	7.9	18.2	2.00	1.00	0.93	0.33	0.30	75.00
11	2.50	8.3	19.6	1.95	1.00	0.93	0.31	0.29	74.46
12	2.75	8.7	21.0	1.46	0.99	0.91	0.30	0.27	71.95
13	3.00	9.1	22.2	0.89	0.96	0.93	0.28	0.25	69.76

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1	0.00	4.3	5.0	ORTHOGONAL	ORIGIN				
2	0.25	4.3	6.5	2.00	1.00	0.93	0.53	0.49	90.00
3	0.50	4.3	8.0	2.00	1.00	0.93	0.52	0.48	90.00
4	0.75	4.3	9.5	2.00	1.00	0.93	0.52	0.48	90.00
5	1.00	4.3	11.1	2.00	1.00	0.93	0.51	0.48	90.00
6	1.25	4.3	12.6	2.00	1.00	0.93	0.51	0.48	90.00
7	1.50	4.3	14.1	2.00	1.00	0.93	0.51	0.48	90.00
8	1.75	4.3	15.6	2.00	1.00	0.93	0.51	0.47	90.00
9	2.00	4.3	17.1	2.00	1.00	0.93	0.51	0.47	90.00
10	2.25	4.3	18.6	2.00	1.00	0.93	0.51	0.47	90.00
11	2.50	4.3	20.2	2.00	1.00	0.93	0.51	0.47	90.00
12	2.75	4.3	21.7	2.00	1.00	0.93	0.51	0.47	90.00

11

CORE USAGE

OBJECT CODE= 18312 BYTES, ARRAY AREA= 25108 BYTES, TOTAL AREA AVAILABLE= 145504 BYTES

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COMPILE TIME= 1.86 SEC, EXECUTION TIME= 13.51 SEC, TAMU/WATFIV - VER 1 LEV 2 AUGUST 1970 DATE= 71/140

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## VI. DYNAMIC RESPONSE OF Laterally LOADED OFFSHORE PILING

This program computes displacements, velocities and accelerations at each node of a given pile. It also determines the values of positive and negative permanent set which occurs during the event.

The program first computes and assembles the pile stiffness matrix. Next, an equivalent platform stiffness is added to the pile stiffness matrix. The mass matrix of the pile and platform are computed and added.

A determination is now made as to the location of the pile with respect to the mean water level and a given point along a wave crest.

At this point the program branches and one of six possible paths is taken. Each of the six cases is a subprogram containing fourth - order Runge-Kutta solutions for six distinct situations. By using the six cases a more efficient program is possible.

If further information than the following listing is required the reader is referred to the Sea Grant Report Number 224, by Hayes E. Ross, Jr., entitled "Dynamic Response of Laterally Loaded Offshore Piling", at Texas A&M University, published August, 1970.

```

C
C   DIMENSION ARRAYS
C
1   DIMENSION ELK(4,4), ELG(4,4), VK12(30,30), VK21(30,30), VK22(30,30)
2   DIMENSION ESSAG(20), DATE(5)
3   COMMON/CASI/VK(30,30), UTIL(30,30), VM(30,1), BCDISP(30,1), BCVEL(30,1
  1), TIME1, DELTAT, UPPLIM, NDFR, NROW, NOW1, NOW2, NITER, NWRITE, NOVOP,
  2 NOMOP, ELPROP(30,6), PILSTM(30,30)
4   COMMON/CASII/ELSOIL(30,6), PSETP(30), PSETN(30), TEMPP(30), TEMPN(30),
  1STIFFM(30), SOLMAS(30), NUSOIL, NUMMTP, K2
5   COMMON/CASIII/VC(30,1), CSJ(30)
6   COMMON/CASIV/VAI(30,1), NUBOTF
7   COMMON/CASV/          PI, WAVET, WAVEL, YWAT, WAVEH, CMP, COP, YTROUG,
  1 DISTTR, K1, K3, K4, NUTOPE, NUBOT
8   COMMON/STRD/SDMCOE, VELOO, ACON

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C
C   *NROW* IS THE ROW DIMENSION OF ALL OF THE ABOVE ARRAYS EXCEPT
C   ELK AND ELG. IF THE SIZE OF THESE ARRAYS ARE CHANGED THEN *NROW*
C   MUST BE CHANGED ACCORDINGLY
C

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9   NROW = 30

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C
C   DEFINE CONSTANTS
C

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10  GRAV = 386.0
11  PI = 3.14159
12  PI4 = PI/4.0

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C
C   READ DATA
C

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13  1100 READ(5,504) (ESSAG(J), J=1,20)
14  READ(5,504) (DATE(J), J=1,5)
15  READ(5,500) NUMM, NUMMTP, NCASE, NOW1, NOW2, NOP1, NOS1, NOVOP, NOMOP
16  NDFR = NUMM + 1
17  K2 = NUMMTP + 1
18  NUSOIL = NDFR - NUMMTP
19  IF(NOP1.EQ.0) GO TO 451
20  READ(5,501) PDIA, PLEN, PARFA, PINERT, PELAS, PDEN
21  DO 450 J = 1, NUMM
22  ELPROP(J,1) = PDIA
23  FLPROP(J,2) = PLEN
24  ELPROP(J,3) = PARFA
25  ELPROP(J,4) = PINERT
26  FLPROP(J,5) = PELAS
27  450 ELPROP(J,6) = PDEN
28  GO TO 453
29  451 CONTINUE
30  DO 452 J = 1, NUMM
31  452 READ(5,501) (ELPROP(J,K), K = 1,6)
32  453 CONTINUE
33  IF(NOS1.EQ.0) GO TO 455
34  READ(5,501) SOILK, SOILC, SOILN, SOILD, SOILUL
35  DO 454 J = 1, NUSOIL
36  ELSOIL(J,1) = SOILK
37  ELSOIL(J,2) = SOILC
38  ELSOIL(J,3) = SOILN
39  ELSOIL(J,4) = SOILD
40  454 ELSOIL(J,5) = SOILUL
41  GO TO 457

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42 455 CONTINUE
43   DO 456 J = 1,NUSOIL
44 456 READ(5,501) (ELSOIL(J,K), K = 1,5)
45 457 CONTINUE
46   READ(5,503) PKTOPH,PKTOPR,PLOAD,PMTOP,SOILMC
47   READ(5,501)SDMCOE,VELOO
48   READ(5,502) DELTAT,TIMEI,UPPLIM,NWRITE,NITER
49   READ(5,501) (BCDISP(J,1), J = 1,NDFR)
50   READ(5,501) (BCVEL(J,1), J = 1,NDFR)
51   IF(NCASE.EQ.1) GO TO 458
52   READ (5,501) (PSETP(J), J = K2,NDFR)
53   READ (5,501) (PSETN(J), J = K2,NDFR)
54   READ (5,501) (TEMP(J), J = K2,NDFR)
55   READ (5,501) (TEMPN(J), J = K2,NDFR)
56   IF(NCASE.LE.3) GO TO 458
57   READ(5,501) YWAT,WDEN,WDRAG,WMASS
58   COP = 0.5*WDRAG*WDEN/GRAV
59   CMP = WMASS*WDEN*PI4/GRAV
60   IF(NCASE.LE.4) GO TO 458
61   READ(5,501) WAVET,WAVEL,WAVEH
62 458 CONTINUE

C
C
C   WRITE INPUT
63   PILEA = 0.0
64   DO 25 J=1, NUMMTP
65 25 PILEA = PILEA + ELPROP(J,2)/12.
66   PILEF = PILEA
67   DO 26 J=K2, NUMM
68 26 PILE = PILE + ELPROP(J,2)/12.
69   PILEB = PILE-PILEA
70   EREALT = NITER*DELTAT
71   WRITE(6,531) (ESSAG(J),J=1,20), (DATE(J),J=1,5)
72   WRITE(6,532) NOPI,NOSI
73   WRITE(6,548)NOW1,NOW2,NWRITE
74   WRITE(6,533) PILE,PILEB,NUMM,NUMMTP,NDFR,SDMCOE,VELOO
75   WRITE(6,544) PKTOPH,PKTOPR,PMTOP,PLOAD
76   WRITE(6,545) DELTAT,EREALT,NITER,TIMEI
77   WRITE(6,546)UPPLIM,NCASE
78   WRITE(6,534)
79   DO 250 J = 1,NUMM
80   WRITE(6,535) J,ELPROP(J,1),ELPROP(J,2),ELPROP(J,3),ELPROP(J,4),
      1ELPROP(J,5),ELPROP(J,6)
81 250 CONTINUE
82   WRITE(6,536)
83   DO 251 J = 1,NDFR
84   WRITE(6,537) J,BCDISP(J,1),BCVEL(J,1)
85 251 CONTINUE
86   WRITE(6,538) NUSOIL, SOILMC
87   WRITE(6,539)
88   DO 252 J = 1,NUSOIL
89   WRITE(6,540) J,ELSOIL(J,1), ELSOIL(J,2),ELSOIL(J,3),ELSOIL(J,4),
      1ELSOIL(J,5)
90 252 CONTINUE
91   IF(NCASE.EQ.1) GO TO 254
92   WRITE(6,541)
93   DO 253 J = 1,NUSOIL
94   L = NUMMTP+J
95   WRITE(6,542) J,PSETP(L),PSETN(L),TEMP(L),TEMPN(L)
96 253 CONTINUE

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97      IF(NCASE.LE.3) GO TO 254
98      YWATF = YWAT/12.
99      WRITE(6,549) YWATF,WDEN,WORAG,WMASS
100     IF(NCASE.LE.4) GO TO 254
101     WAVEHF = WAVEH/12.
102     WAVELF = WAVE/12.
103     WRITE(6,543) WAVEHF,WAVELF,WAVET
104     254 CONTINUE

C
C      DEFINE MORE CONSTANTS
105     ACON = SDMCOE/VELOC

C
C      INITILIZF ARRAYS
106     DO 36 J = 1,NDFR
107     VM(J,1) = 0.0
108     VC(J,1) = 0.0
109     VA(J,1) = 0.0
110     DO 36 K = 1,NDFR
111     VK(J,K) = 0.0
112     VK12(J,K) = 0.0
113     VK21(J,K) = 0.0
114     VK22(J,K) = 0.0
115     UTIL(J,K) = 0.0
116     36 CONTINUE

C
C      COMPUTE REDUCED STIFFNESS MATRIX OF PILE INCLUDING SIMULATED
C      PLATFORM STIFFNESS
117     DO 700 II = 1,2
118     DO 43 J = 1,NUMM
119     CALL ELSTIF(ELK,ELPROP(J,2), ELPROP(J,4), ELPROP(J,5))
120     CALL ELGEM(ELG,ELPROP(J,2), PLOAD)
121     DO 41 K = 1,4
122     DO 41 L = 1,4
123     41 ELK(K,L) = ELK(K,L) + ELG(K,L)
124     N = J - 1
125     DO 42 JJ = 1,2
126     DO 42 KK = 1,2
127     VK(N+JJ,N+KK) = VK(N+JJ,N+KK) + ELK(JJ,KK)
128     VK12(N+JJ,N+KK) = VK12(N+JJ,N+KK) + ELK(JJ,KK+2)
129     VK21(N+JJ,N+KK) = VK21(N+JJ,N+KK) + ELK(JJ+2,KK)
130     42 VK22(N+JJ,N+KK) = VK22(N+JJ,N+KK) + ELK(JJ+2,KK+2)
131     43 CONTINUE

C
C      ADD SIMULATED PLATFORM STIFFNESS
132     IF(II.EQ.1) GO TO 701
133     VK(1,1) = VK(1,1) + PKTOPH
134     VK22(1,1) = VK22(1,1) + PKTOPR
135     701 CONTINUE
136     CALL INVERS(VK22,NDFR,NROW)
137     CALL MULT(VK12,VK22,UTIL,NDFR,NDFR,NDFR,NROW,NROW,NROW)
138     CALL MULT(UTIL,VK21,VK12,NDFR,NDFR,NDFR,NROW,NROW,NROW)
139     IF(II.EQ.2) GO TO 702
140     DO 703 J = 1,NDFR
141     DO 703 K = 1,NDFR
142     703 PI(STM(J,K)) = VK(J,K) - VK12(J,K)
143     DO 704 J = 1,NDFR

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144      DO 704 K = 1,NDFR
145      VK(J,K) = 0.0
146      VK12(J,K) = 0.0
147      VK21(J,K) = 0.0
148      VK22(J,K) = 0.0
149      704 UTIL(J,K) = 0.0
150      GO TO 700
151      702 CONTINUE
152      DO 44 J = 1,NDFR
153      DO 44 K = 1,NDFR
154      44 VK(J,K) = VK(J,K) - VK12(J,K)
155      700 CONTINUE
156      CALL WRITE(PILSTM,NDFR,NDFR,NROW)
157      CALL WRITE(VK,NDFR,NDFR,NROW)
C
C      ADD SOIL STIFFNESS TO PILE STIFFNESS
158      DO 45 J = 1,NUSOIL
159      45 VK(NUMMTP + J,NUMMTP + J) = VK(NUMMTP + J, NUMMTP + J)
160      1 + ELISOIL(J,1)
      CALL WRITE(VK,NDFR,NDFR,NROW)
C
C      COMPUTE PORTION OF MASS MATRIX DUE TO PILE AND SIMULATED PLATFORM
C      MASS
161      VM(1,1) = 0.5*ELPROP(1,2)*ELPROP(1,3)*ELPROP(1,6)/GRAV + PMTOP
162      VM(NDFR,1) = 0.5*ELPROP(NDFR-1,2)*ELPROP(NDFR-1,3)*ELPROP(NDFR-1,6
163      1)/GRAV
164      KLM = NDFR - 1
165      CK1 = VM(1,1) - PMTOP
166      DO 46 J = 2,KLM
167      CK2 = 0.5*ELPROP(J,2)*ELPROP(J,3)*ELPROP(J,6)/GRAV
168      VM(J,1) = CK1 + CK2
169      CK1 = CK2
170      46 CONTINUE
      CALL WRITE(VM,NDFR,1,NROW)
C
C      COMPUTE PORTION OF MASS MATRIX DUE TO SOIL MASS AND STORE IN
C      SOLMAS
171      SOLMAS(K2) = SOILMC*PI4*ELPROP(K2,1)*ELPROP(K2,1)*ELPROP(K2,2)*
172      1 0.5*ELSOIL(1,4)/GRAV
173      SOLMAS(NDFR) = SOILMC*PI4*ELPROP(NDFR-1,1)*ELPROP(NDFR-1,1)*
174      1 ELPROP(NDFR-1,2)*0.5*ELSOIL(NUSOIL,4)/GRAV
175      CK1 = SOLMAS(K2)
176      KLM = NUSOIL - 1
177      DO 47 J = 2,KLM
178      CK2 = SOILMC*PI4*ELPROP(NUMMTP+J,1)*ELPROP(NUMMTP+J,1)*ELPROP(
179      1 NUMMTP+J,2)*0.5*ELSOIL(J,4)/GRAV
180      SOLMAS(NUMMTP+J) = CK1 + CK2
181      CK1 = CK2
182      47 CONTINUE
C
C      INITILIZE UTIL ARRAYS
183      DO 79 J = 1,NROW
184      DO 79 K = 1,NROW
185      79 UTIL(J,K) = 0.0
186      DO 86 J = K2,NDFR
187      86 VM(J,1) = VM(J,1) + SOLMAS(J)
C

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C      IS NCASE EQUAL TO 1
C
185      IF(NCASE.GT.1) GO TO 80
186      CALL RKI
187      GO TO 1000
188      80 CONTINUE
189      DO 81 J = 1,NDFR
190      UTIL(J,20) = VM(J,1)
191      81 STIFFM(J) = VK(J,J)
192      DO 82 J = 1,NUSOIL
193      82 UTIL(NUMMTP+J,30) = ELSOIL(J,1)*ELSOIL(J,5)
C
C      IS NCASE EQUAL TO 2
C
194      IF(NCASE.GT.2) GO TO 83
195      CALL RKII
196      GO TO 1000
197      83 CONTINUE
198      DO 84 J = 1,NUSOIL
199      84 UTIL(NUMMTP+J,10) = UTIL(NUMMTP+J,30)*ELSOIL(J,2)
C
C      COMPUTATION OF SOIL DAMPING MATRIX
C
200      DO 49 J = 1,NUSOIL
201      VC(NUMMTP + J,1) = ELSOIL(J,1)*ELSOIL(J,2)
202      49 CSJ(NUMMTP + J) = VC(NUMMTP + J,1)
C
C      IS NCASE EQUAL TO 3
C
203      IF(NCASE.GT.3) GO TO 85
204      CALL RKIII
205      GO TO 1000
206      85 CONTINUE
C
C      DETERMINE MWL WITH RESPECT TO PILE DIMENSIONS
C
207      I = 0
208      DISTL = 0.0
209      50 DISTL = DISTL + ELPROP(NUMMTP - I,2)
210      IF((YWAT - DISTL).LT.0.0) GO TO 51
211      IF(I.EQ.NUMMTP - 1) GO TO 51
212      I = I + 1
213      GO TO 50
214      51 CONTINUE
C
C      DETERMINE - NAMWL = NODE NO. IMMEDIATELY ABOVE MWL
C      NBMWL = NODE NO. IMMEDIATELY BELOW MWL
C
215      NAMWL = NUMMTP - I
216      NBMWL = NAMWL + 1
C
C      DETERMINE - DISTNA = DISTANCE TO NAMWL FROM MWL
C      DISTNB = DISTANCE TO NBMWL FROM MWL
C
217      DISTNA = DISTL - YWAT
218      DISTNB = ELPROP(NAMWL,2) - DISTNA
219      IF(NCASE.GT.4) GO TO 54
220      IF(DISTNA.GT.DISTNB) GO TO 52
221      FFFLEN = DISTNB - ELPROP(NAMWL,2)*0.5
222      AVEDIA = ELPROP(NAMWL,1)

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223      VM(NAMWL,1) = VM(NAMWL,1) + CMP*AVEDIA*AVEDIA*EFFLEN
224      VA(NAMWL,1) = COP*AVEDIA*EFFLEN
225      NUBOTE = NAMWL
226      GO TO 53
227      52 NUBOTE = NBMWL
228      IF(NUBOTE.EQ.NUMMTP + 1) GO TO 600
229      EFFLEN = DISTNB + 0.5*ELPROP(NBMWL,2)
230      AVEDIA = (DISTNB*ELPROP(NAMWL,1) + 0.5*ELPROP(NBMWL,2)*ELPROP(
1 NBMWL,1))/(DISTNB + 0.5*ELPROP(NBMWL,2))
231      GO TO 601
232      600 EFFLEN = DISTNB
233      AVEDIA = ELPROP(NAMWL,1)
234      601 CONTINUE
235      VM(NBMWL,1) = VM(NBMWL,1) + CMP*AVEDIA*AVEDIA*EFFLEN
236      VA(NBMWL,1) = COP*AVEDIA*EFFLEN
237      53 CONTINUE
238      GO TO 75
239      54 CONTINUE

C
C      DETERMINE YCREST & YTROUGH
C
C      NNN = NCASE - 3
C      GO TO (55,56,57,58) NNN
240      55 YCREST = YWAT + WAVEH/2.
241      YTROUG = YWAT - WAVEH/2.
242      GO TO 60
C      56 CALL WAVE2
C      GO TO 60
C      57 CALL WAVE3
C      GO TO 60
C      58 CALL WAVE4
243      60 CONTINUE

C
C      DETERMINE - NUTOPE = MOST UPPER NODE AFFECTED BY WAVE CREST
C      NUBOTE = MOST LOWER NODE AFFECTED BY WAVE TROUGH
C
244      DISTL = YWAT + DISTNA
245      I = 1
246      65 IF((YCREST - DISTL).LT.0.0) GO TO 66
247      IF(I.FO.NAMWL) GO TO 66
248      DISTL = DISTL + ELPROP(NAMWL - I,2)
249      I = I + 1
250      GO TO 65
251      66 CONTINUE

C
C      DETERMINE - DISTCR = DISTANCE BETWEEN YCREST & NUTOP
C      NUTOP = NODE IMMEDIATELY ABOVE CRFST
C
252      DISTCR = DISTL - YCREST
253      NUTOP = NAMWL - I + 1
254      IF(DISTCR.LT.(ELPROP(NUTOP,2)*0.5)) GO TO 67
255      NUTOP = NUTOP + 1
256      GO TO 68
257      67 NUTOPE = NUTOP
258      68 CONTINUE
259      DISTL = YWAT - DISTNB
260      I = 0
261      69 IF((DISTL - YTROUG).LT.0.0) GO TO 70
262      IF(NBMWL + I.EQ.NUMMTP + 1) GO TO 70

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263      DISTL = DISTL - ELPROP(NBMWL+1,2)
264      I = I + 1
265      GO TO 69
266      70 CONTINUE

C
C      DETERMINF - DISTTR = DISTANCE BETWEEN YTROUG & NUBOT
C      NUBOT = NODE IMMEDIATELY BELOW TROUGH

267      DISTTR = YTROUG - DISTL
268      NUBOT = NBMWL + I
269      IF(DISTTR.LT.(ELPROP(NUBOT - 1,2)*0.5)) GO TO 71
270      NUBOTE = NUBOT - 1
271      GO TO 72
272      71 NUBOTE = NUBOT
273      72 CONTINUE
274      75 CONTINUE

C
C      COMPUTE EFFECTIVE WATER MASS & WATER DAMPING MATRIX
C      (FROM NODES 'NUBOTE + 1' THRU 'NUMMTP + 1')
C

275      WRITE(6,526) NAMWL,NBMWL,NUBOTE,NUTCPE,NUTOP,NUBOT
276      WRITE(6,527) DISTNA,DISTNB,CDP,CMP,YCREST,YTROUG,DISTCR,DISTTR
277      IF(NCASE.EQ.6) GO TO 88
278      JJ = NUBOTE + 1
279      IF(JJ.GT.NUMMTP) GO TO 77
280      DO 76 J = JJ,NUMMTP
281      AVEDIA = (ELPROP(J-1,1) + ELPROP(J,1))*0.5
282      EFFLEN = (ELPROP(J-1,2) + ELPROP(J,2))*0.5
283      VM(J,1) = VM(J,1) + CMP*AVEDIA*AVEDIA*EFFLEN
284      76 VA(J,1) = CDP*AVEDIA*EFFLEN
285      77 CONTINUE
286      IF(JJ.GT.NUMMTP + 1) GO TO 400
287      VM(NUMMTP + 1,1) = VM(NUMMTP + 1,1) + ((ELPROP(NUMMTP,1))*2)*0.5*
1 ELPROP(NUMMTP,2)*CMP
288      VA(NUMMTP + 1,1) = CDP*ELPROP(NUMMTP,1)*0.5*ELPROP(NUMMTP,2)
289      CALL WRITE(VA,NDFR,1,NROW)
290      CALL WRITE(VM,NDFR,1,NROW)
291      400 CONTINUE
292      IF(NCASE.GT.4) GO TO 88
293      DO 87 J = 1,NDFR
294      87 UTIL(J,20) = VM(J,1)
295      CALL RKIV
296      GO TO 1000
297      88 CONTINUE

C
C      DEFINE CONSTANTS
C

298      K1 = NUTOPE + 1
299      K3 = NUTOPE - 1
300      K4 = NUBOTE + 1
301      IF(NCASE.EQ.6) GO TO 89
302      CALL RKV
303      GO TO 1000
304      89 CONTINUE
305      DO 90 J = 1,NDFR
306      90 UTIL(J,20) = VM(J,1)
307      CALL RKVI
308      1000 CONTINUE
309      IF(NCASE.EQ.1) GO TO 1001
310      WRITE(6,547)

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311      DO 275 J = 1,NUSOIL
312      L = NUMMTP + J
313      275 WRITE(6,542) J,PSETP(L),PSETN(L),TEMPP(L),TEMPN(L)
C
C      FORMAT STATEMENTS
C
314      500 FORMAT(16I5)
315      501 FORMAT(8F10.0)
316      502 FORMAT(3F10.0,2I5)
317      503 FORMAT(2F20.0,4F10.0)
318      504 FORMAT(20A4)
319      525 FORMAT(1H1)
320      526 FORMAT(///2X,16I5)
321      527 FORMAT(///2X,8E15.6)
322      528 FORMAT(2X,'TIME = '2F15.6)
323      529 FORMAT(2X,8E15.6)
324      530 FORMAT(2X,5F15.6,15)
325      531 FORMAT(1H1,48X,'DYNAMIC RESPONSE OF OFFSHORE PILING' / 53X,'SUBJECTED TO WAVE ACTION' ///5X,'IDENTIFICATION - ',20A4 ///5X,'DATE 20F JUN - ',5A4///)
326      532 FORMAT(5X,'INPUT OPTIONS - NOP1 = ',I1,', NOS1 = ',I1///)
327      533 FORMAT(1H0,5X,'PILE CHARACTERISTICS -'/29X,'TOTAL LENGTH = ',F6.1,1' FT.' /29X,'EMBEDDED LFNGTH = ',F6.1,' FT.'/29X,'NO. OF ELEMENTS 2= ',I2/29X,'NO. OF ELEMENTS ABOVE MUD LINE = ',I2/29X,'NO. OF DEGR 3EFS OF FREEDOM = ',I2./29X,'STRUCTURAL DAMPING COEFFICIENT = ',4 F5.3./29X,'CUT-OFF VELOCITY FOR STRUCTURAL DAMPING = ',F4.2,5 ' IN./SEC.'///)
328      534 FORMAT(1H0,54X,'PILE ELEMENT PROPERTIES'//// 10X,'ELEMENT',7X,1'DIAMETER',11X,'LENGTH',13X,'AREA',12X,'MOMENT OF',8X,'MODULUS OF',2,10X,'DENSITY',79X,'INERTIA',10X,'ELASTICITY',26X,'(IN.)',13X,3'(IN.)',11X,'(SQ. IN.)',8X,'(IN. TO 4TH)',5X,'(LB./SQ. IN.)',5X,4'(LB./CU. IN.)'///)
329      535 FORMAT(1H .11X,I2,3X,6(5X,E13.6))
330      536 FORMAT(/// 56X,'INITIAL CONDITIONS' ///46X,'NODE',6X,'DISPLACEMENT',8X,'VELOCITY',59X,'(IN.)',11X,'(IN./SEC.)'///)
331      537 FORMAT(1H .46X,I2,1X,2(5X,E13.6))
332      538 FORMAT(/// 5X,'SOIL CHARACTERISTICS -' / 28X,'NO. OF NODES = ',I2 1/28X,'MASS COEFFICIENT = ',F4.2 ///54X,'SOIL ELEMENT PROPERTIES' 2///)
333      539 FORMAT(14X,'NODE',9X,'STIFFNESS',12X,'DAMPING',13X,'VELOCITY',12X,1'DENSITY',13X,'ULTIMATE',49X,'FACTOR',13X,'EXPONENT',30X,'DISPLACEMENT',27X,'(LB./IN.)',11X,'(SEC./IN.)',10X,'(UNITLESS)',8X,3'(LB./CU. IN.)',11X,'(IN.)'///)
334      540 FORMAT(1H .14X,I2,1X,5(7X,E13.6))
335      541 FORMAT(///54X,'INITIAL SOIL CONDITIONS'////15X,'NODE',10X,'POS. P 1ERMANENT',10X,'NEG. PERMANENT',13X,'MAX. POS.',15X,'MAX. NEG.', / 235X,'SET',21X,'SET',17X,'DISPLACEMENT',12X,'DISPLACEMENT',34X,3'(IN.)',19X,'(IN.)',19X,'(IN.)',19X,'(IN.)'///)
336      542 FORMAT(1H .15X,I2,1X,4(11X,F13.6))
337      543 FORMAT(///5X,'WAVE CHARACTERISTICS -'/29X,'THEORY EMPLOYED - AIRY 1'/29X,'WAVE HEIGHT = ',F4.1,' FT.'/29X,'WAVE LENGTH = ',F6.1,' FT. 2'/29X,'WAVE PERIOD = ',F4.1,' SEC.'///)
338      544 FORMAT(1H0,5X,'PLATFORM CHARACTERISTICS -'/33X,'EQUIVALENT LATERAL 1 STIFFNESS = ',E13.6,' LB./IN.'/33X,'EQUIVALENT ROTATIONAL STIFFNE 2SS = ',F13.6,' IN.-LB./RD.'/33X,'EQUIVALENT MASS = ',E13.6,3' LB.-SQ. SEC./IN.'/33X,'AXIAL PILE LOAD = ',E13.6,' LB.'///)
339      545 FORMAT(1H0,5X,'RUNGE KUTTA PARAMETERS -'/31X,'TIME INCREMENT = ',1F6.4,' SEC.'/31X,'EVENT REAL TIME = ',F5.1,' SEC.'/31X,'NO. OF INC 2REMENTS = ',I5/31X,'EVENT START TIME = ',F5.2,' SEC.')
340      546 FORMAT(31X,'UPPER LIMIT ON NODE 1 DISPLACEMENT = ',F6.1,' IN.'/)

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1 31X,'NCASE = ',I2,/)
341 547 FORMAT(////54X,' FINAL SOIL CONDITIONS'////15X,'NODE',10X,'POS. P
    IERMANENT',10X,'NEG. PERMANENT',13X,'MAX. POS.',15X,'MAX. NEG.', /
    235X,'SET',21X,'SET',17X,'DISPLACEMENT',12X,'DISPLACEMENT'/34X,
    3'(IN.)',19X,'(IN.)',19X,'(IN.)',19X,'(IN.)'//)
342 548 FORMAT(1H0,5X,'OUTPUT OPTIONS - NOW1 = ',I1,', NOW2 = ',I1/
    1 ??X,'RUNGA-KUTTA OUTPUT PRINTED EVERY ',I2,' ITERATIONS')
343 549 FORMAT(////5X,'WATER CHARACTERISTICS -'/30X,'WATER DEPTH = ',F6.1,
    1' FT.'/30X,'WATER DENSITY = ',F5.3,' LB/CU. IN.'/30X,'DRAG COEFFIC
    2IENT = ',F4.2/30X,'MASS COEFFICIENT = ',F4.2//)
344 1001 CONTINUE
345 GO TO 1100
346 END
C
C RUNGA KUTTA CASE I
C
347 SUBROUTINE RKI
348 COMMON/CAS1/VK(30,30),UTIL(30,30),VM(30,1),BCDISP(30,1),BCVEL(30,1
    1),TIMEI,DELTAT,UPPLIM,NDFR,NROW,NOW1,NOW2,NITER,NWRITE,NOVOP,
    ? NOMOP,ELPROP(30,6),PILSTM(30,30)
349 COMMON/COEF/ZK(30,4),YK(30,4),TIME,JJ,KKQ,KQUE
350 KKQ = 1
351 TIME = TIMEI
352 CALL INJTW
C
C BEGIN RUNGA KUTTA
C
353 DO 226 JJ = 1,NITER
354 TIM = TIME
355 KQUE = JJ/NWRITE - (JJ - 1)/NWRITE
356 DO 202 J = 1,NDFR
357 UTIL(J,1) = BCDISP(J,1)
358 202 UTIL(J,2) = BCVEL(J,1)
C
C BEGIN LOOP FOR FOUR COEFFICIENTS
C
359 DO 214 JJ = 1,4
C
C MULT STIFFNESS MATRIX BY DISPLACEMENTS
C
360 DO 203 J = 1,NDFR
361 UTIL(J,6) = 0.0
362 DO 203 K = 1,NDFR
363 203 UTIL(J,6) = UTIL(J,6) + UTIL(K,1)*VK(J,K)
C
C COMPUTE ACCELERATIONS
C
364 DO 204 J = 1,NDFR
365 204 UTIL(J,8) = -UTIL(J,6)/VM(J,1)
C
C COMPUTE COEFFICIENTS
C
366 CALL COFFFS
367 214 CONTINUE
C
C CHECK SIZE OF NODE 1 DISPLACEMENT
C
368 IF (ABS(BCDISP(1,1)).GT.UPPLIM) GO TO 1000
369 CALL OUTPWR

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370      276 CONTINUE
371      GO TO 1001
372      1000 WRITE(6,500)
373      500 FORMAT(//5X,***** DISPLACEMENT AT NODE 1 EXCEEDED UPPLIM *****)
374      529 FORMAT(2X,8E15.6)
375      1001 RETURN
376      END

C
C      RUNGA KUTTA CASE II SUBROUTINE
C

377      SUBROUTINE RK11
378      COMMON/CAS1/VK(30,30),UTIL(30,30),VM(30,1),BCDISP(30,1),BCVEL(30,1),
1) TIMEI,DELTAT,UPPLIM,NDFR,NROW,NOW1,NOW2,NITER,NWRITE,NOVUP,
2) NOMOP,FLPROP(30,6),PILSTM(30,30)
379      COMMON/CASII/ELSDIL(30,6),PSETP(30),PSETN(30),TEMPP(30),TEMFN(30),
1)STIFFM(30),SOLMAS(30),NUSOIL,NUMMTP,K2
380      COMMON/COEF/ZK(30,4),YK(30,4),TIME,JJ,KKO,KQOE
381      KKO = 1
382      TIME = TIMEI
383      CALL INITWR

C
C      BEGIN RUNGA KUTTA
C

384      DO 226 JJJ = 1,NITER
385      TIM = TIME
386      KQOE = JJJ/NWRITE - (JJJ - 1)/NWRITE
387      DO 202 J = 1,NDFR
388      UTIL(J,1) = BCDISP(J,1)
389      202 UTIL(J,2) = BCVEL(J,1)

C
C      DETERMINE SOIL PROPERTIES
C

390      CALL SOILP1

C
C      BEGIN LOOP FOR FOUR COEFFICIENTS
C

391      DO 214 JJ = 1,4

C
C      MULT STIFFNESS MATRIX BY DISPLACEMENTS
C

392      DO 203 J = 1,NDFR
393      UTIL(J,6) = 0.0
394      DO 203 K = 1,NDFR
395      203 UTIL(J,6) = UTIL(J,6) + UTIL(K,1)*VK(J,K)

C
C      COMPUTE ACCELERATIONS
C

396      DO 204 J = 1,NDFR
397      204 UTIL(J,8) = (-UTIL(J,6) - UTIL(J,15))/UTIL(J,20)

C
C      COMPUTE COEFFICIENTS
C

398      CALL COEFFS
399      214 CONTINUE

C
C      CHECK SIZE OF NODE 1 DISPLACEMENT
C

400      IF (ABS(BCDISP(1,1)).GT.UPPLIM) GO TO 1000
401      CALL OUTPWR

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402 226 CONTINUE
403 GO TO 1001
404 1000 WRITE(6,500)
405 529 FORMAT(2X,8F15.6)
406 500 FORMAT(///5X,'***** DISPLACEMENT AT NODE 1 EXCEEDED UPPLIM *****')
407 1001 RETURN
408 END

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C
C RUNGA KUTTA CASE III
C

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409 SUBROUTINE RKIII
410 COMMON/CAS1/VK(30,30),UTIL(30,30),VM(30,1),BCDISP(30,1),BCVEL(30,1
1),TIMEI,DELTAT,UPPLIM,NDFR,NROW,NOW1,NOW2,NITER,NWRITE,NOVOP,
2 NOMOP,FLPROP(30,6),PILSTM(30,30)
411 COMMON/CASII/ELSOIL(30,6),PSETP(30),PSETN(30),TEMP(30),TEMPN(30),
1STIFFM(30),SOLMAS(30),NUSOIL,NUMMTP,K2
412 COMMON/CASIII/VC(30,1),CSJ(30)
413 COMMON/CNEF/ZK(30,4),YK(30,4),TIME,JJ,KKQ,KQOE
414 KKQ = 1
415 TIME = TIMEI
416 CALL INITWR

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C
C BEGIN RUNGA KUTTA
C

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417 DO 226 JJJ = 1,NITER
418 TIM = TIME
419 KQOF = JJJ/NWRITE - (JJJ - 1)/NWRITE
420 DO 202 J = 1,NDFR
421 UTIL(J,1) = BCDISP(J,1)
422 202 UTIL(J,2) = BCVEL(J,1)

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C
C DETERMINE SOIL PROPERTIES
C

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423 CALL SOILP2

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C
C BEGIN LOOP FOR FOUR COEFFICIENTS
C

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424 DO 214 JJ = 1,4

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C
C MULT STIFFNESS MATRIX BY DISPLACEMENTS
C

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425 DO 203 J = 1,NDFR
426 UTIL(J,6) = 0.0
427 DO 203 K = 1,NDFR
428 203 UTIL(J,6) = UTIL(J,6) + UTIL(K,1)*VK(J,K)

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C
C COMPUTE EFFECTS OF STRUCTURAL DAMPING
C

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429 CALL STRDAP

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C
C COMPUTE SOIL DAMPING
C

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430 CALL SOLDAP

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C
C COMPUTE ACCELERATIONS
C

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431 DO 204 J = 1,NDFR
432 204 UTIL(J,8) = (-UTIL(J,6) - UTIL(J,5) - UTIL(J,15))/UTIL(J,20)

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C      COMPUTE COEFFICIENTS
C
433      CALL COEFFS
434      214 CONTINUE
C
C      CHECK SIZE OF NODE 1 DISPLACEMENT
C
435      IF (ABS(BCDISP(1,1)).GT.UPPLIM) GO TO 1000
436      CALL OUTPHR
437      226 CONTINUE
438      GO TO 1001
439      1000 WRITE(6,500)
440      529 FORMAT(2X,8E15.6)
441      500 FORMAT(///5X,'***** DISPLACEMENT AT NODE 1 EXCEEDED UPPLIM *****')
442      1001 RETURN
443      END
C
C      RUNGA KUTTA CASE IV
C
444      SUBROUTINE RKIV
445      COMMON/CASI/VK(30,30),UTIL(30,30),VM(30,1),BCDISP(30,1),BCVEL(30,1),
1) TIMEI,DELTA,UPPLIM,NDFR,NRDW,NOW1,NOW2,NITER,NWRITE,NOVOP,
2) NOMOP,FLPROP(30,6),PILSTM(30,30)
446      COMMON/CASII/ELSOIL(30,6),PSETP(30),PSFTN(30),TEHPP(30),TEMPN(30),
1)STIFFM(30),SOLMAS(30),NUSOIL,NUMMTP,K2
447      COMMON/CASIII/VC(30,1),CSJ(30)
448      COMMON/CASIV/VA(30,1),NUBOTF
449      COMMON/COEF/ZK(30,4),YK(30,4),TIME,JJ,KKQ,KQUE
450      KKQ = 1
451      TIME = TIMEI
452      CALL INITWR
C
C      BEGIN RUNGA KUTTA
C
453      DO 226 JJJ = 1,NITER
454      TIM = TIME
455      KQUE = JJJ/NWRITE - (JJJ - 1)/NWRITE
456      DO 202 J = 1,NDFR
457      UTIL(J,1) = BCDISP(J,1)
458      202 UTIL(J,2) = BCVEL(J,1)
C
C      DETERMINE SOIL PROPERTIES
C
459      CALL SOILP2
C
C      BEGIN LOOP FOR FOUR COEFFICIENTS
C
460      DO 214 JJ = 1,4
C
C      MULT STIFFNESS MATRIX BY DISPLACEMENTS
C
461      DO 203 J = 1,NDFR
462      UTIL(J,6) = 0.0
463      DO 203 K = 1,NDFR
464      203 UTIL(J,6) = UTIL(J,6) + UTIL(K,1)*VK(J,K)
C
C      COMPUTE EFFECTS OF STRUCTURAL DAMPING
C
465      CALL STRDAP

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C
C
C   COMPUTE SOIL DAMPING
466   CALL SOLDAP
C
C   COMPUTE WATER DAMPING FORCES
467   DO 210 J = NUBOTE,K2
468   210 UTIL(J,7) = VA(J,1)*UTIL(J,2)*ABS(UTIL(J,2))
C
C   COMPUTE ACCELERATIONS
469   DO 204 J = 1,NDFR
470   204 UTIL(J,8) = (-UTIL(J,5) - UTIL(J,6) - UTIL(J,7) - UTIL(J,15))/
      1 UTIL(J,20)
C
C   COMPUTE COEFFICIENTS
471   CALL COEFFS
C
472   214 CONTINUE
C   CHECK SIZE OF NODE 1 DISPLACEMENT
473   IF (ABS(HCDISP(1,1)).GT.UPPLIM) GO TO 1000
474   CALL OUTPWR
475   226 CONTINUE
476   GO TO 1001
477   1000 WRITE(6,500)
478   529 FORMAT(2X,RE15.6)
479   500 FORMAT(///5X,***** DISPLACEMENT AT NODE 1 EXCEEDED UPPLIM *****)
480   1001 RETURN
481   END
C
C   SUBROUTINE RKV
C
482   SUBROUTINE RKV
483   COMMON/CAS I/VK(30,30),UTIL(30,30),VM(30,1),BCDISP(30,1),BCVEL(30,1
1),TIMEI,DELTAT,UPPLIM,NDFR,NROW,NOW1,NOW2,NITER,NWRITE,NOVOP,
2 NOMP,ELPROP(30,6),PILSTM(30,30)
484   COMMON/CAS II/ELSOIL(30,6),PSETP(30),PSETN(30),TEMPP(30),TEMPN(30),
1STIFFH(30),SOLMAS(30),NUSOIL,NUMMTP,K2
485   COMMON/CAS III/VC(30,1),CSJ(30)
486   COMMON/CAS IV/VA(30,1),NUBOTE
487   COMMON/CAS V/
      PI,WAVET,WAVEL,YWAT,WAVEH,CMP,CDP,YTROUG,
1 DISTTR,K1,K3,K4,NUTOPE,NUBOT
488   COMMON/COEF/ZK(30,4),YK(30,4),TIME,JJ,KKQ,KOUE
C
C   DEFINE AIRY WAVE CONSTANTS
489   SIGMA = 2.*PI/WAVET
490   WANU = 2.*PI/WAVEL
491   SINHKH = SINH(WANU*YWAT)
492   AMPLIT = WAVEH/2.
493   ASIGS = AMPLIT*SIGMA/SINHKH
C
C   COMPUTE WAVE PARAMETERS
494   IF(K3.LE.0) GO TO 620
495   DO 195 J = 1,K3

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496      195 UTIL(J,20) = VM(J,1)
497      620 CONTINUE
498      DO 196 J = K4,NUMMTP
499      196 UTIL(J,20) = VM(J,1)
C
C      DEFINE CONSTANT ARRAYS USED WITHIN WAVE HT. & BELOW
C      UTIL(J,24) = AVERAGE DIAMETERS
C      UTIL(J,25) = EFFECTIVE WATER MASS
C      UTIL(J,26) = WATER DAMPING MATRIX
C      UTIL(J,27) = (COSH(WANU*SBOT))*ASIGS
C      UTIL(J,28) = (COSH(WANU*SBOT))*ASIGS*SIGMA
C      UTIL(J,29) = UTIL(J,25)*UTIL(J,28)
C
500      UTIL(1,24) = ELPROP(1,1)
501      DO 619 J = 2,NUMMTP
502      619 UTIL(J,24) = (ELPROP(J-1,1) + ELPROP(J,1))*0.5
503      UTIL(K2,24) = ELPROP(NUMMTP,1)
504      IF(K1.GT.NUMMTP) GO TO 621
505      DO 197 J = K1,NUMMTP
506      EFFLEN = (ELPROP(J-1,2) + ELPROP(J,2))*0.5
507      UTIL(J,25) = CMP*UTIL(J,24)*UTIL(J,24)*EFFLEN
508      197 UTIL(J,26) = CDP*UTIL(J,24)*EFFLEN
509      621 CONTINUE
510      UTIL(K2,25) = CMP*UTIL(K2,24)*UTIL(K2,24)*ELPROP(K2-1,2)*0.5
511      UTIL(K2,26) = CDP*UTIL(K2,24)*ELPROP(K2-1,2)*0.5
512      SBOT = 0.0
513      DO 198 J = NUTOPE,NUMMTP
514      198 SBOT = SBOT + ELPROP(J,2)
515      DO 199 J = NUTOPE,K2
516      UTIL(J,27) = (COSH(WANU*SBOT))*ASIGS
517      UTIL(J,28) = -(UTIL(J,27))*SIGMA
518      UTIL(J,29) = UTIL(J,25)*UTIL(J,28)
519      199 SBOT = SBOT - ELPROP(J,2)
C
C      LOCATE INITIAL WAVE POSITION
C
520      ETA = AMPLIT*COS(SIGMA*TIMEI)
521      SBOT = YWAT + ETA
522      I = 1
523      DISTL = YTROUG + ELPROP(NUBOT-I,2) - DISTTR
524      231 IF(DISTL.GT.SBOT) GO TO 232
525      IF(I.EQ.NUBOT - 1) GO TO 232
526      I = I + 1
527      DISTL = DISTL + ELPROP(NUBOT-I,2)
528      GO TO 231
529      232 CONTINUE
530      NODFA = NUBOT - I
531      WRITE(6,526) K1,K2,K3,K4,NODFA
532      WRITE(6,527) SIGMA,WANU,SINHKKH,AMPLIT,ASIGS,ETA,SBOT,DISTL
533      WRITE(6,529) (UTIL(J,25), J = 1,NDFR)
534      WRITE(6,529) (UTIL(J,26), J = 1,NDFR)
535      WRITE(6,529) (UTIL(J,27), J = 1,NDFR)
536      WRITE(6,529) (UTIL(J,28), J = 1,NDFR)
537      WRITE(6,529) (UTIL(J,29), J = 1,NDFR)
538      KKQ = 1
539      TIMEF = TIMEI
540      CALL INITWR
C
C      BEGIN RUNGA KUTTA
C

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541      DO 226 JJJ = 1,NITER
542      TIM = TIME
543      KQUF = JJJ/NWRITE - (JJJ - 1)/NWRITE
544      DO 202 J = 1,NDFR
545      UTIL(J,1) = BCDISP(J,1)
546      202 UTIL(J,2) = BCVEL(J,1)
      C
      C      DETERMINE SOIL PROPERTIES
      C
547      CALL SOILP2
      C
      C      BEGIN LOOP FOR FOUR COEFFICIENTS
      C
548      DO 214 JJ = 1,4
      C
      C      MULT STIFFNESS MATRIX BY DISPLACEMENTS
      C
549      DO 203 J = 1,NDFR
550      UTIL(J,6) = 0.0
551      DO 203 K = 1,NDFR
552      203 UTIL(J,6) = UTIL(J,6) + UTIL(K,1)*VK(J,K)
      C
      C      COMPUTE EFFECTS OF STRUCTURAL DAMPING
      C
553      CALL STRDAP
      C
      C      COMPUTE SOIL DAMPING
      C
554      CALL SOLDAP
      C
      C      DETERMINE WATER LEVEL WRT PILE
      C
555      ARGUM = SIGMA*TIM
556      SINST = SIN(ARGUM)
557      COSST = COS(ARGUM)
558      FTA = AMPLIT*COSST
559      SBOT = YWAT + FTA
560      XDIST = DISTL - SBOT
561      IF(XDIST) 233,236,236
562      233 I = 1
563      234 DISTL = DISTL + ELPROP(NODEA - I,2)
564      IF(DISTL.GT.SBOT) GO TO 235
565      I = I + 1
566      GO TO 234
567      235 NODEFA = NODEA - I
568      XDIST = DISTL - SBOT
569      GO TO 240
570      236 IF(XDIST.GT.ELPROP(NODEA,2)) GO TO 237
571      GO TO 240
572      237 I = 0
573      238 DISTL = DISTL - ELPROP(NODEA + I,2)
574      IF(DISTL.LT.SBOT) GO TO 239
575      I = I + 1
576      GO TO 238
577      239 NODEA = NODEA + I
578      DISTL = DISTL + ELPROP(NODEA,2)
579      XDIST = DISTL - SBOT
580
**WARNING** BLANK CARD ENCOUNTERED
581      240 CONTINUE

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582      VLA = ELPROP(NODEA,2) - XDIST
583      XLEN = ELPROP(NODEA,2)*0.5
584      IF(VLA.GT.XLEN) GO TO 241
585      NODEE = NODEA + 1
586      EFFLEN = VLA + ELPROP(NODEE,2)*0.5
587      GO TO 242
588 241 EFFLEN = VLA - XLEN
589      NODEE = NODEA
590 242 CONTINUE

C
C      INITIALIZF ARRAYS NOT AFFECTED BY WAVE
C      UTIL(J,20) = TOTAL MASS
C      UTIL(J,22) = TOTAL INERTIA FORCE
C      UTIL(J,23) = TOTAL INTERACTION DRAG FORCE
C

591      K7 = NODEE - 1
592      IF(NUTOPE.EQ.NODEE) GO TO 248
593      DO 243 J = NUTOPE,K7
594      UTIL(J,20) = VM(J,1)
595      UTIL(J,22) = 0.0
596 243 UTIL(J,23) = 0.0
597 248 CONTINUE

C
C      DETERMINE VA & UTIL(J,20) FROM 'NODEE' TO 'NUBOTE'
C

598      UTIL(NODEE,20) = VM(NODEE,1) + EFFLEN*UTIL(NODEE,24)*UTIL(NODEE,
1 24)*CMP
599      VA(NODEE,1) = CDP*UTIL(NODEE,24)*EFFLEN
600      K6 = NODEE + 1
601      IF(NODEE.EQ.NUBOTE) GO TO 245
602      DO 244 J = K6,NUBOTE
603      UTIL(J,20) = VM(J,1) + UTIL(J,25)
604 244 VA(J,1) = UTIL(J,26)
605 245 CONTINUE

C
C      DETERMINE UTIL(J,21) = PARTICLE VELOCITIES
C

606      AVFDEP = (SBOT + SBOT - EFFLEN)*0.5
607      CONST = COSH(WANU*AVEDEP)*ASIGS
608      UTIL(NODEE,21) = CONST*COSST
609      DO 246 J = K6,K2
610 246 UTIL(J,21) = UTIL(J,27)*COSST

C
C      DETERMINE UTIL(J,22)
C

611      UTIL(NODEE,22) = -CONST*SIGMA*SINST*CMP*EFFLEN*UTIL(NODEE,24)*
1 UTIL(NODEE,24)
612      IF(NODEE.EQ.K2) GO TO 249
613      DO 247 J = K6,K2
614 247 UTIL(J,22) = UTIL(J,29)*SINST
615 249 CONTINUE

C
C      DETERMINE UTIL(J,23)
C

616      DO 605 J = NODEE,K2
617      RELVEL = UTIL(J,21) - UTIL(J,2)
618 605 UTIL(J,23) = VA(J,1)*RELVEL*ABS(RELVEL)

C
C      COMPUTF ACCELERATIONS

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C
619      DN 205 J = 1,NDFR
620      205 UTIL(J,8) = (UTIL(J,22) + UTIL(J,23) - UTIL(J,5) - UTIL(J,6) -
          1 UTIL(J,15))/UTIL(J,20)
C
C      COMPUTE COEFFICIENTS
C
621      CALL COEFFS
622      214 CONTINUE
C
C      CHECK SIZE OF NODE 1 DISPLACEMENT
C
623      IF (ABS(BCDISP(1,1)).GT.UPPLIM) GO TO 1000
624      CALL OUTPWR
625      226 CONTINUE
626      GO TO 1001
627      1000 WRITE(6,500)
628      500 FORMAT(///5X,'***** DISPLACEMENT AT NODE 1 EXCEEDED UPPLIM *****')
629      *26 FORMAT(///2X,16I5)
630      527 FORMAT(///2X,8E15.6)
631      529 FORMAT(2X,8E15.6)
632      1001 RETURN
633      END
C
C      SUBROUTINE RKVI
C
634      SUBROUTINE RKVI
635      COMMON/CASI/VK(30,30),UTIL(30,30),VM(30,1),BCDISP(30,1),BCVEL(30,1),
          TIME1,DELTA,UPPLIM,NDFR,NROW,NOW1,NOW2,NITER,NWRITE,NOVOP,
          2 NMODP,ELPROP(30,6),PILSTM(30,30)
636      COMMON/CASII/ELSOIL(30,6),PSETP(30),PSETN(30),TEMPP(30),TEMPN(30),
          1STIFFM(30),SOLMAS(30),NUSOIL,NUMMTP,K2
637      COMMON/CASIII/VC(30,1),CSJ(30)
638      COMMON/CASIV/VA(30,1),NUBOT
639      COMMON/CASV/PI,WAVET,WAVEL,YWAT,WAVEH,CMP,CDP,YTRUUG,
          1 DISTTR,K1,K3,K4,NUTOPE,NUBOT
640      COMMON/COFF/ZK(30,4),YK(30,4),TIME,JJ,KKQ,KQUE
C
C      DEFINE AIRY WAVE CONSTANTS
C
641      SIGMA = 2.*PI/WAVET
642      WANU = 2.*PI/WAVEL
643      SINHHK = SINH(WANU*YWAT)
644      AMPLIT = WAVEH/2.
645      ASIGS = AMPLIT*SIGMA/SINHHK
C
C      COMPUTE WAVE PARAMETERS
C
C
C      DEFINE CONSTANT ARRAYS USED WITHIN WAVE HT. & BELOW
C
C      UTIL(J,24) = AVERAGE DIAMETERS
C      UTIL(J,25) = EFFECTIVE WATER MASS
C      UTIL(J,26) = WATER DAMPING MATRIX
C      UTIL(J,27) = (COSH(WANU*SBOT))*ASIGS
C      UTIL(J,28) = (COSH(WANU*SBOT))*ASIGS*SIGMA
C      UTIL(J,29) = UTIL(J,25)*UTIL(J,28)
C
646      UTIL(1,24) = ELPROP(1,1)
647      DN 619 J = 2,NUMMTP

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648 619 UTIL(J,24) = (ELPROP(J-1,1) + ELPROP(J,1))*0.5
649   UTIL(K2,24) = ELPROP(NUMMTP,1)
650   IF(K1.GT.NUMMTP) GO TO 621
651   DO 197 J = K1,NUMMTP
652     EFFLEN = (ELPROP(J-1,2) + ELPROP(J,2))*0.5
653     UTIL(J,25) = CMP*UTIL(J,24)*UTIL(J,24)*EFFLEN
654 197 UTIL(J,26) = CDP*UTIL(J,24)*EFFLEN
655 621 CONTINUE
656   UTIL(K2,25) = CMP*UTIL(K2,24)*UTIL(K2,24)*ELPROP(K2-1,2)*0.5
657   UTIL(K2,26) = CDP*UTIL(K2,24)*ELPROP(K2-1,2)*0.5
658   SBOT = 0.0
659   DO 198 J = NUTOPE,NUMMTP
660 198 SBOT = SBOT + ELPROP(J,2)
661   DO 199 J = NUTOPE,K2
662     UTIL(J,27) = (COSH(WANU*SBOT))*ASIGS
663     UTIL(J,28) = -(UTIL(J,27))*SIGMA
664     UTIL(J,29) = UTIL(J,25)*UTIL(J,28)
665 199 SBOT = SBOT - ELPROP(J,2)

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C
C LOCATE INITIAL WAVE POSITION
C

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666   ETA = AMPLIT*COS(SIGMA*TIMEI)
667   SBOT = YWAT + ETA
668   I = 1
669   DISTL = YTROUG + ELPROP(NUBOT-I,2) - DISTTR
670 231 IF(DISTL.GT.SBOT) GO TO 232
671   IF(I.EQ.NUBOT - 1) GO TO 232
672   I = I + 1
673   DISTL = DISTL + ELPROP(NUBOT-I,2)
674   GO TO 231
675 232 CONTINUE
676   NODEA = NUBOT - I
677   WRITE(6,526) K1,K2,K3,K4,NODEA
678   WRITE(6,527) SIGMA,WANU,SINHKKH,AMPLIT,ASIGS,ETA,SBOT,DISTL
679   WRITE(6,529) (UTIL(J,25), J = 1,NDFR)
680   WRITE(6,529) (UTIL(J,26), J = 1,NDFR)
681   WRITE(6,529) (UTIL(J,27), J = 1,NDFR)
682   WRITE(6,529) (UTIL(J,28), J = 1,NDFR)
683   WRITE(6,529) (UTIL(J,29), J = 1,NDFR)
684   KKO = 1
685   TIME = TIMEI
686   CALL INITWR

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C
C BEGIN RUNGA KUTTA
C

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687   DO 276 JJJ = 1,NITER
688     TIM = TIME
689     KOUE = JJJ/NWRITE - (JJJ - 1)/NWRITE
690     DO 202 J = 1,NDFR
691       UTIL(J,1) = BCDISP(J,1)
692 202 UTIL(J,2) = BCVEL(J,1)

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C
C DETERMINE SOIL PROPERTIES
C

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693   CALL SOILP2

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C
C BEGIN LOOP FOR FOUR COEFFICIENTS
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694   DO 214 JJ = 1,4

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C      MULT STIFFNESS MATRIX BY DISPLACEMENTS
C
695      DO 203 J = 1,NDFR
696      UTIL(J,6) = 0.0
697      DO 203 K = 1,NDFR
698      203 UTIL(J,6) = UTIL(J,6) + UTIL(K,1)*VK(J,K)
C
C      COMPUTE EFFECTS OF STRUCTURAL DAMPING
C
699      CALL STRDAP
C
C      COMPUTE SOIL DAMPING
C
700      CALL SOLDAP
C
C      DETERMINE WATER LEVEL WRT PILE
C
701      ARGUM = SIGMA*TIM
702      SINST = SIN(ARGUM)
703      COSST = COS(ARGUM)
704      ETA = AMPLIT*COSST
705      SBOT = YWAT + ETA
706      XDIST = DISTL - SBOT
707      IF(XDIST) 233,236,236
708      233 I = 1
709      234 DISTL = DISTL + ELPROP(NODEA - 1,2)
710      IF(DISTL.GT.SBOT) GO TO 235
711      I = I + 1
712      GO TO 234
713      235 NODEA = NODEA - I
714      XDIST = DISTL - SBOT
715      GO TO 240
716      236 IF(XDIST.GT.ELPROP(NODEA,2)) GO TO 237
717      GO TO 240
718      237 I = 0
719      238 DISTL = DISTL - ELPROP(NODEA + 1,2)
720      IF(DISTL.LT.SBOT) GO TO 239
721      I = I + 1
722      GO TO 238
723      239 NODEA = NODEA + I
724      DISTL = DISTL + ELPROP(NODEA,2)
725      XDIST = DISTL - SBOT
726      240 CONTINUE
727      VLA = FLPROP(NODEA,2) - XDIST
728      XLEN = ELPROP(NODEA,2)*0.5
729      IF(VLA.GT.XLEN) GO TO 241
730      NODEE = NODEA + 1
731      EFFLEN = VLA + ELPROP(NODEE,2)*0.5
732      GO TO 242
733      241 EFFLEN = VLA - XLEN
734      NODEE = NODEA
735      242 CONTINUE
C
C      INITILIZE ARRAYS NOT AFFECTED BY WAVE
C      UTIL(J,22) = TOTAL INERTIA FORCE
C      UTIL(J,23) = TOTAL DRAG FORCE
C
736      K7 = NODEE - 1
737      IF(NUTOPE.EQ.NODEE) GO TO 248
738      DO 243 J = NUTOPE,K7
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739      UTIL(J,22) = 0.0
740      243 UTIL(J,23) = 0.0
741      248 CONTINUE
C
C      DETERMINE VA FROM 'NODEE' TO 'NUBOTE'
C
742      VA(NODEE,1) = COP*UTIL(NODEE,24)*EFFLEN
743      K6 = NODEE + 1
744      IF(NODEE.EQ.NUBOTE) GO TO 245
745      DO 244 J = K6,NUBOTE
746      244 VA(J,1) = UTIL(J,26)
747      245 CONTINUE
C
C      DETERMINE UTIL(J,21) = PARTICLE VELOCITIES
C
748      AVEDEP = (SBOT + SBOT - EFFLEN)*0.5
749      CONST = COSH(WANU*AVEDEP)*ASIGS
750      UTIL(NODEE,21) = CCNST*COSST
751      DO 246 J = K6,K2
752      246 UTIL(J,21) = UTIL(J,27)*COSST
C
C      DETERMINE UTIL(J,22)
C
753      UTIL(NODEE,22) = -CONST*SIGMA*SINST*CMP*EFFLEN*UTIL(NODEE,24)*
1 UTIL(NODEE,24)
754      IF(NODEE.EQ.K2) GO TO 249
755      DO 247 J = K6,K2
756      247 UTIL(J,22) = UTIL(J,29)*SINST
757      249 CONTINUE
C
C      DETERMINE UTIL(J,23)
C
758      DO 605 J = NODEE,K2
759      605 UTIL(J,23) = VA(J,1)*UTIL(J,21)*ABS(UTIL(J,21))
C
C      COMPUTE ACCELERATIONS
C
760      DO 205 J = 1,NDFR
761      205 UTIL(J,8) = (UTIL(J,22) + UTIL(J,23) - UTIL(J,5) - UTIL(J,6) -
1 UTIL(J,15))/UTIL(J,20)
C
C      COMPUTE COEFFICIENTS
C
762      CALL COEFFS
763      214 CONTINUE
C
C      CHECK SIZE OF NODE 1 DISPLACEMENT
C
764      IF (ABS(BCDISP(1,1)).GT.UPPLIM) GO TO 1000
765      CALL OUTPWR
766      226 CONTINUE
767      GO TO 1001
768      1000 WRITE(6,500)
769      500 FORMAT(///5X,***** DISPLACEMENT AT NODE 1 EXCEEDED UPPLIM *****)
770      526 FORMAT(///2X,16I5)
771      527 FORMAT(///2X,8E15.6)
772      529 FORMAT(2X,8E15.6)
773      1001 RETURN
774      END

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C
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C
SUBROUTINE STRDAP
775
776 SUBROUTINE STRDAP
COMMON/CASI/VK(30,30),UTIL(30,30),VM(30,1),BCDISP(30,1),BCVEL(30,1
1),TIMEI,DELTAT,UPPLIM,NDFR,NROW,NOW1,NOW2,NITER,NWRITE,NOVOP,
2 NOMOP,ELPROP(30,6),PILSTM(30,30)
777 DO 1 J = 1,NDFR
778 IF(UTIL(J,1)) 2,3,3
779 3 IF(UTIL(J,2)) 4,5,5
780 4 UTIL(J,6) = UTIL(J,6)*(1. - GSTR(UTIL(J,2)))
781 GO TO 1
782 5 UTIL(J,6) = UTIL(J,6)*(1. + GSTR(UTIL(J,2)))
783 GO TO 1
784 2 IF(UTIL(J,2)) 6,7,7
785 6 UTIL(J,6) = UTIL(J,6)*(1. + GSTR(UTIL(J,2)))
786 GO TO 1
787 7 UTIL(J,6) = UTIL(J,6)*(1. - GSTR(UTIL(J,2)))
788 1 CONTINUE
789 RETURN
790 END

```

```

C
C
C
SUBROUTINE TO COMPUTE VALUE OF DAMPING COEFFICIENT

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791 FUNCTION GSTR(PVEL)
792 COMMON/STRD/SDMCOE,VELOO,ACON
793 CON = ABS(PVEL)
794 IF(CON.GT.VELOO) GO TO 1
795 GSTR = ACON*CON
796 RETURN
797 1 GSTR = SDMCOE
798 RETURN
799 END

```

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C
C
C
SUBROUTINE TO COMPUTE NONLINEAR SOIL PROPERTIES (NO DAMPING)

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800 SUBROUTINE SOILP1
801 COMMON/CASI/VK(30,30),UTIL(30,30),VM(30,1),BCDISP(30,1),BCVEL(30,1
1),TIMEI,DELTAT,UPPLIM,NDFR,NROW,NOW1,NOW2,NITER,NWRITE,NOVOP,
2 NOMOP,ELPROP(30,6),PILSTM(30,30)
802 COMMON/CASII/ELSOIL(30,6),PSETP(30),PSETN(30),TEMPP(30),TEMPN(30),
1STIFFM(30),SOLMAS(30),NUSOIL,NUMMTP,K2

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C
C
C
DETERMINE SOIL PROPERTIES

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803 DO 699 J = K2,NDFR
804 M = J - NUMMTP

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C
C
C
CHECK DIRECTION OF MOTION

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805 IF(BCDISP(J,1)*BCVEL(J,1)) 667,650,650

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C
C
C
DISPLACEMENT INCREASING

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806 650 IF(BCDISP(J,1)) 662,654,654

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C
C
DISPLACEMENT INCREASING ON POSITIVE SIDE

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C
807 654 IF(BCDISP(J,1) - PSETP(J)) 655,656,656
808 655 VK(J,J) = STIFFM(J) - ELSOIL(M,1)
809 UTIL(J,15) = 0.0
810 UTIL(J,20) = VM(J,1)
811 GO TO 651
812 656 IF(BCDISP(J,1) - PSETP(J) - ELSOIL(M,5)) 657,657,658
813 657 UTIL(J,15) = 0.0
814 IF(PSFTP(J) - .000001) 700,701,701
815 700 VK(J,J) = STIFFM(J)
816 UTIL(J,20) = VM(J,1) + SOLMAS(J)*BCDISP(J,1)/ELSOIL(M,5)
817 GO TO 651
818 701 VK(J,J) = STIFFM(J) - ELSOIL(M,1)*(PSETP(J)/BCDISP(J,1))
819 UTIL(J,20) = VM(J,1) + SOLMAS(J)*(BCDISP(J,1) - PSETP(J))/
1 ELSOIL(M,5)
GO TO 651
820
821 658 VK(J,J) = STIFFM(J) - ELSOIL(M,1)
822 UTIL(J,20) = VM(J,1) + SOLMAS(J)
823 UTIL(J,15) = UTIL(J,30)
824 651 IF(BCDISP(J,1) - TEMPP(J)) 699,699,652
825 652 TEMPP(J) = BCDISP(J,1)
826 IF(TEMPP(J) - ELSOIL(M,5)) 699,699,653
827 653 PSFTP(J) = BCDISP(J,1) - ELSOIL(M,5)
828 GO TO 699

C
C DISPLACEMENT INCREASING ON NEGATIVE SIDE
C
829 662 IF(BCDISP(J,1) - PSETN(J)) 664,663,663
830 663 VK(J,J) = STIFFM(J) - ELSOIL(M,1)
831 UTIL(J,15) = 0.0
832 UTIL(J,20) = VM(J,1)
833 GO TO 659
834 664 IF(BCDISP(J,1) - PSFTN(J) + ELSOIL(M,5)) 666,665,665
835 665 UTIL(J,15) = 0.0
836 IF(PSETN(J) + .000001) 702,702,703
837 702 VK(J,J) = STIFFM(J) - ELSOIL(M,1)*(PSETN(J)/BCDISP(J,1))
838 UTIL(J,20) = VM(J,1) - SOLMAS(J)*(BCDISP(J,1) - PSFTN(J))/
1 ELSOIL(M,5)
GO TO 659
839
840 703 VK(J,J) = STIFFM(J)
841 UTIL(J,20) = VM(J,1) - SOLMAS(J)*BCDISP(J,1)/ELSOIL(M,5)
842 GO TO 659
843 666 VK(J,J) = STIFFM(J) - ELSOIL(M,1)
844 UTIL(J,15) = -UTIL(J,30)
845 UTIL(J,20) = VM(J,1) + SOLMAS(J)
846 659 IF(BCDISP(J,1) - TEMPN(J)) 660,699,699
847 660 TEMPN(J) = BCDISP(J,1)
848 IF(TEMPN(J) + ELSOIL(M,5)) 661,699,699
849 661 PSFTN(J) = BCDISP(J,1) + ELSOIL(M,5)
850 GO TO 699

C
C DISPLACEMENT DECREASING
C
851 667 UTIL(J,15) = 0.0
852 IF(BCDISP(J,1)) 670,668,668

C
C DISPLACEMENT DECREASING ON POSITIVE SIDE
C
853 668 IF(BCDISP(J,1).LE.PSETP(J)+ELSOIL(M,5).AND.BCDISP(J,1).GE.PSFTP(J)
1) GO TO 669

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854      VK(J,J) = STIFFM(J) - ELSOIL(M,1)
855      UTIL(J,20) = VM(J,1)
856      GO TO 699
857      669 IF(PSETP(J) - .000001) 704,705,705
858      704 VK(J,J) = STIFFM(J)
859      UTIL(J,20) = VM(J,1) + SOLMAS(J)*BCDISP(J,1)/ELSOIL(M,5)
860      GO TO 699
861      705 VK(J,J) = STIFFM(J) - ELSOIL(M,1)*PSETP(J)/BCDISP(J,1)
862      UTIL(J,20) = VM(J,1) + SOLMAS(J)*(BCDISP(J,1) - PSETP(J))/
      1 ELSOIL(M,5)
863      GO TO 699
      C
      C      DISPLACEMENT DECREASING ON NEGATIVE SIDE
      C
864      670 IF(BCDISP(J,1).LE.PSETN(J).AND.BCDISP(J,1).GE.PSETN(J)
      1 - ELSOIL(M,5)) GO TO 671
865      VK(J,J) = STIFFM(J) - ELSOIL(M,1)
866      UTIL(J,20) = VM(J,1)
867      GO TO 699
868      671 IF(PSETN(J) + .000001) 706,706,707
869      706 VK(J,J) = STIFFM(J) - ELSOIL(M,1)*PSETN(J)/BCDISP(J,1)
870      UTIL(J,20) = VM(J,1) - SOLMAS(J)*(BCDISP(J,1) - PSETN(J))/
      1 ELSOIL(M,5)
      GO TO 699
872      707 VK(J,J) = STIFFM(J)
873      UTIL(J,20) = VM(J,1) - SOLMAS(J)*BCDISP(J,1)/ELSOIL(M,5)
874      699 CONTINUE
875      RETURN
876      END
      C
      C      SUBROUTINE TO COMPUTE NONLINEAR SOIL PROPERTIES (INCLUDING DAMPING)
      C
877      SUBROUTINE SOILP2
878      COMMON/CASI/VK(30,30),UTIL(30,30),VM(30,1),BCDISP(30,1),BCVEL(30,1)
      1),TIMEI,DELTAT,UPPLIM,NDFR,NROW,NDWL,NDW2,NITER,NWRITE,NOVOP,
      2 NQMOP,ELPROPI(30,6),PILSTM(30,30)
879      COMMON/CASII/ELSOIL(30,6),PSETP(30),PSETN(30),TEMPP(30),TEMPN(30),
      1STIFFM(30),SOLMAS(30),NUSOIL,NUMMTP,K2
880      COMMON/CASIII/VC(30,1),CSJ(30)
      C
      C      DETERMINE SOIL PROPERTIES
      C
881      DD 699 J = K2,NDFR
882      M = J - NUMMTP
      C
      C      CHECK DIRECTION OF MOTION
      C
883      IF(BCDISP(J,1)*BCVEL(J,1)) 667,650,650
      C
      C      DISPLACEMENT INCREASING
      C
884      650 IF(BCDISP(J,1))662,654,654
      C
      C      DISPLACEMENT INCREASING ON POSITIVE SIDE
      C
885      654 IF(BCDISP(J,1) - PSETP(J)) 655,656,656
886      655 VK(J,J) = STIFFM(J) - ELSOIL(M,1)
887      UTIL(J,15) = 0.0
888      UTIL(J,20) = VM(J,1)
889      VC(J,1) = 0.0

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890      GO TO 651
891      656 IF(BCDISP(J,1) - PSETP(J) - ELSOIL(M,5)) 657,657,658
892      657 UTIL(J,15) = 0.0
893      IF(PSETP(J) - .000001) 700,701,701
894      700 VK(J,J) = STIFFM(J)
895      UTIL(J,20) = VM(J,1) + SOLMAS(J)*BCDISP(J,1)/ELSOIL(M,5)
896      VC(J,1) = CSJ(J)
897      GO TO 651
898      701 VK(J,J) = STIFFM(J) - ELSOIL(M,1)*(PSETP(J)/BCDISP(J,1))
899      UTIL(J,20) = VM(J,1) + SOLMAS(J)*(BCDISP(J,1) - PSETP(J))/
      1 ELSOIL(M,5)
900      VC(J,1) = CSJ(J)*(BCDISP(J,1) - PSETP(J))/BCDISP(J,1)
901      GO TO 651
902      658 VK(J,J) = STIFFM(J) - ELSOIL(M,1)
903      UTIL(J,20) = VM(J,1) + SOLMAS(J)
904      UTIL(J,15) = UTIL(J,30)
905      VC(J,1) = UTIL(J,10)/BCDISP(J,1)
906      651 IF(BCDISP(J,1) - TEMPP(J)) 699,699,652
907      652 TEMPP(J) = BCDISP(J,1)
908      IF(TEMPP(J) - ELSOIL(M,5)) 699,699,653
909      653 PSETP(J) = BCDISP(J,1) - ELSOIL(M,5)
910      GO TO 699

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C
C      DISPLACEMENT INCREASING ON NEGATIVE SIDE
C

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911      662 IF(BCDISP(J,1) - PSETN(J)) 664,663,663
912      663 VK(J,J) = STIFFM(J) - ELSOIL(M,1)
913      UTIL(J,15) = 0.0
914      UTIL(J,20) = VM(J,1)
915      VC(J,1) = 0.0
916      GO TO 659
917      664 IF(BCDISP(J,1) - PSETN(J) + ELSOIL(M,5)) 666,665,665
918      665 UTIL(J,15) = 0.0
919      IF(PSETN(J) + .000001) 702,702,703
920      702 VK(J,J) = STIFFM(J) - ELSOIL(M,1)*(PSETN(J)/BCDISP(J,1))
921      UTIL(J,20) = VM(J,1) - SOLMAS(J)*(BCDISP(J,1) - PSETN(J))/
      1 ELSOIL(M,5)
922      VC(J,1) = CSJ(J)*(BCDISP(J,1) - PSETN(J))/BCDISP(J,1)
923      GO TO 659
924      703 VK(J,J) = STIFFM(J)
925      UTIL(J,20) = VM(J,1) - SOLMAS(J)*BCDISP(J,1)/ELSOIL(M,5)
926      VC(J,1) = CSJ(J)
927      GO TO 659
928      666 VK(J,J) = STIFFM(J) - ELSOIL(M,1)
929      UTIL(J,15) = -UTIL(J,30)
930      UTIL(J,20) = VM(J,1) + SOLMAS(J)
931      VC(J,1) = -UTIL(J,10)/BCDISP(J,1)
932      659 IF(BCDISP(J,1) - TEMPN(J)) 660,699,699
933      660 TEMPN(J) = BCDISP(J,1)
934      IF(TEMPN(J) + ELSOIL(M,5)) 661,699,699
935      661 PSETN(J) = BCDISP(J,1) + ELSOIL(M,5)
936      GO TO 699

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C
C      DISPLACEMENT DECREASING
C

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937      667 UTIL(J,15) = 0.0
938      VC(J,1) = 0.0
939      IF(BCDISP(J,1)) 670,668,668

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C
C      DISPLACEMENT DECREASING ON POSITIVE SIDE

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C
940 668 IF(BCDISP(J,1).LE.PSETP(J)+ELSOIL(M,5).AND.BCDISP(J,1).GE.PSETP(J)
      1) GO TO 669
941     VK(J,J) = STIFFM(J) - ELSOIL(M,1)
942     UTIL(J,20) = VM(J,1)
943     GO TO 699
944 669 IF(PSETP(J) - .000001) 704,705,705
945 704 VK(J,J) = STIFFM(J)
946     UTIL(J,20) = VM(J,1) + SOLMAS(J)*BCDISP(J,1)/ELSOIL(M,5)
947     GO TO 699
948 705 VK(J,J) = STIFFM(J) - ELSOIL(M,1)*PSETP(J)/BCDISP(J,1)
949     UTIL(J,20) = VM(J,1) + SOLMAS(J)*(BCDISP(J,1) - PSETP(J))/
      1 ELSOIL(M,5)
950     GO TO 699
C
C     DISPLACEMENT DECREASING ON NEGATIVE SIDE
C
951 670 IF(BCDISP(J,1).LE.PSETN(J).AND.BCOISP(J,1).GE.PSETN(J)
      1 - ELSOIL(M,5)) GO TO 671
952     VK(J,J) = STIFFM(J) - ELSOIL(M,1)
953     UTIL(J,20) = VM(J,1)
954     GO TO 699
955 671 IF(PSETN(J) + .000001) 706,706,707
956 706 VK(J,J) = STIFFM(J) - ELSOIL(M,1)*PSETN(J)/BCDISP(J,1)
957     UTIL(J,20) = VM(J,1) - SOLMAS(J)*(BCDISP(J,1) - PSETN(J))/
      1 ELSOIL(M,5)
958     GO TO 699
959 707 VK(J,J) = STIFFM(J)
960     UTIL(J,20) = VM(J,1) - SOLMAS(J)*BCDISP(J,1)/ELSOIL(M,5)
961 699 CONTINUE
962     RETURN
963     FND
C
C     SUBROUTINE TO COMPUTE RUNGA KUTTA COEFFICIENTS & WRITE ACCELERATIONS
C
964     SUBROUTINE COEFFS
965     COMMON/CASI/VK(30,30),UTIL(30,30),VM(30,1),BCDISP(30,1),BCVEL(30,1
      1),TIMEI,DELTAT,UPPLIM,NDFR,NROW,NOW1,NOW2,NITER,NWRITE,NOVOP,
      2 NOMOP,ELPROP(30,6),PILSTM(30,30)
966     COMMON/COEF/ZK(30,4),YK(30,4),TIME,JJ,KK,KOUE
C
C     COMPUTE COEFFICIENTS
C
967     DO 209 J = 1,NDFR
968     ZK(J,JJ) = DELTAT*UTIL(J,8)
969 209 YK(J,JJ) = DELTAT*UTIL(J,2)
970     IF(JJ.GT.2) GO TO 211
971     DO 210 J = 1,NDFR
972     UTIL(J,1) = BCDISP(J,1) + YK(J,JJ)/2.0
973 210 UTIL(J,2) = BCVEL(J,1) + ZK(J,JJ)/2.0
974     TIM = TIME + DELTAT*.5
975     GO TO 213
976 211 IF(JJ.EQ.4) GO TO 213
977     DO 212 J = 1,NDFR
978     UTIL(J,1) = BCDISP(J,1) + YK(J,3)
979 212 UTIL(J,2) = BCVEL(J,1) + ZK(J,3)
980     TIM = TIME + DELTAT
981 213 CONTINUE
C     COMPUTE AND WRITE ACCELERATIONS

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982      IF(JJ.NF.4) GO TO 230
983      IF(NOW2.EQ.1.AND.KKO.EQ.1) GO TO 221
984      GO TO 224
985  221 CONTINUE
986      DO 222 J = 1,NDFR
987  222 UTIL(J,8) = (ZK(J,1)/DELTAT)/386.
988      WRITE(6,529)(UTIL(J,8),J = 1,NDFR)
989  224 CONTINUE
990      DO 225 J = 1,NDFR
991      ZK(J,1) = 0.166667*(ZK(J,1) + 2.*ZK(J,2) + 2.*ZK(J,3) + ZK(J,4))
992      YK(J,1) = 0.166667*(YK(J,1) + 2.*YK(J,2) + 2.*YK(J,3) + YK(J,4))
993      BCDISP(J,1) = BCDISP(J,1) + YK(J,1)
994  225 BCVEL(J,1) = BCVEL(J,1) + ZK(J,1)
995      KKO = KQUE
996  230 CONTINUE
997      529 FORMAT(2X,8E15.6)
998      RETURN
999      END
C
C      SUBROUTINE TO COMPUTE SOIL DAMPING FORCES
C
1000     SUBROUTINE SOLDAP
1001     COMMON/CASI/VK(30,30),UTIL(30,30),VM(30,1),BCDISP(30,1),BCVEL(30,1),
1002     TIMFI,DELTAT,UPPLIM,NDFR,NROW,NOW1,NOW2,NITER,NWRITE,NOVOP,
1003     2 NMOOP,ELPROP(30,6),PILSTM(30,30)
1004     COMMON/CASII/ELSOIL(30,6),PSFTP(30),PSETN(30),TEMPP(30),TEMPN(30),
1005     ISTIFF(30),SOLMAS(30),NUSOIL,NUMMTP,K2
1006     COMMON/CASIII/VC(30,1),CSJ(30)
1007     DO 201 J = 1,NUSOIL
1008     K = NUMMTP + J
1009     IF(UTIL(K,2).LT.0.0) GO TO 202
1010     UTIL(K,5) = (UTIL(K,2)**ELSOIL(J,3))*ABS(UTIL(K,1))*VC(K,1)
1011     GO TO 201
1012  202 UTIL(K,5) = -(ABS(UTIL(K,2))**ELSOIL(J,3))*ABS(UTIL(K,1))*VC(K,1)
1013     )
1014  201 CONTINUE
1015     RETURN
1016     END
C
C      SUBROUTINE ELSTIF
C
20     1013     SUBROUTINE ELSTIF(X,VL,VI,E)
19     1014     DIMENSION X(4,4)
18     1015     C2 = 2.*F*VI/VL
17     1016     C4 = 2.*C2
16     1017     C6 = 3.*C2/VL
15     1018     C12 = 2.*C6/VL
14     1019     X(1,1) = C12
13     1020     X(1,2) = -C12
12     1021     X(1,3) = C6
11     1022     X(1,4) = C6
10     1023     X(2,2) = C12
9     1024     X(2,3) = -C6
8     1025     X(2,4) = -C6
7     1026     X(3,3) = C4
6     1027     X(3,4) = C2
5     1028     X(4,4) = C4
4     1029     DO 1 L = 1,3
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1030      K = L + 1
1031      DO 1 M = K,4
1032      1 X(M,L) = X(L,M)
1033      RETURN
1034      END

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C
C      SUBROUTINE TO COMPUTE GEOMETRICAL ELEMENT STIFFNESS MATRIX
C

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1035      SUBROUTINE ELGEO(X,VL,P)
1036      DIMENSION X(4,4)
1037      X(1,1) = 1.2
1038      X(1,2) = -1.2
1039      X(1,3) = VL*0.1
1040      X(1,4) = X(1,3)
1041      X(2,2) = 1.2
1042      X(2,3) = -X(1,3)
1043      X(2,4) = X(2,3)
1044      X(3,3) = 0.133333*VL*VL
1045      X(3,4) = -X(3,3)*0.5
1046      X(4,4) = X(3,3)
1047      DO 1 L = 1,3
1048      K = L + 1
1049      DO 1 M = K,4
1050      1 X(M,L) = X(L,M)
1051      CON = P/VL
1052      DO 2 J = 1,4
1053      DO 2 K = 1,4
1054      2 X(J,K) = X(J,K)*CON
1055      RETURN
1056      END

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C
C      A SUBROUTINE TO INVERT A MATRIX
C

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1057      SUBROUTINE INVERS(P,N,ND)
1058      IMPLICIT REAL*8(A,T)
1059      DIMENSION A(30,30), P(ND,ND)
1060      DO 101 I=1,N
1061      DO 101 J=1,N
1062      101 A(I,J)=P(I,J)
1063      DO 100 I = 1,N
C      TAKE RECIPROCAL OF PIVOT ELEMENT
1064      A(I,I) = 1./A(I,I)
1065      DO 200 J = 1,N
1066      IF(J.EQ.I) GO TO 200
1067      A(I,J) = A(I,J)*A(I,I)
1068      200 CONTINUE
1069      DO 202 K = 1,N
1070      IF(K.EQ.I) GO TO 202
1071      TEMP = A(K,I)
1072      A(K,I) = 0.
1073      DO 203 J = 1,N
1074      A(K,J) = A(K,J)-TEMP*A(I,J)
1075      203 CONTINUE
1076      202 CONTINUE
1077      100 CONTINUE
1078      DO 102 I=1,N
1079      DO 102 J=1,N
1080      102 P(I,J)=A(I,J)

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1081      RETURN
1082      END
C
C      A SUBROUTINE TO WRITE A MATRIX
C
1083      SUBROUTINE WRITE(X,IR,IC,NROWX)
1084      DIMENSION X(NROWX,IC)
1085      WRITE (6,501) IR,IC
1086      501 FORMAT(5X,26HTHE FOLLOWING MATRIX IS A .I2.4H BY .I2.1H.//)
1087      K = 1
1088      502 WRITE(6,503) K,(X(K,J),J = 1,IC)
1089      503 FORMAT(5X,4HROW .I2.1P6E17.7/(11X,1P6E17.7))
1090      IF(K-IR)504,505,505
1091      504 K = K + 1
1092      GO TO 502
1093      505 RETURN
1094      END
C
C      A SUBROUTINE TO MULTIPLY TWO MATRICES
C
1095      SUBROUTINE MULT(X,Y,W,IRX,ICX,ICY,NROWX,NROWY,NROWW)
1096      DIMENSION X(NROWX,ICX), Y(NROWY,ICY), W(NROWW,ICY)
1097      DO 508 J = 1,IRX
1098      DO 508 K = 1,ICY
1099      W(J,K) = 0.
1100      DO 508 L = 1,ICX
1101      508 W(J,K) = W(J,K) + X(J,L)*Y(L,K)
1102      RETURN
1103      END
C
C      SUBROUTINE TO WRITE INITIAL CONDITIONS
C
1104      SUBROUTINE INITWR
1105      COMMON/CASI/VK(30,30),UTIL(30,30),VM(30,1),BCDISP(30,1),BCVEL(30,1),
1106      TIME1,DELTAT,UPPLIM,NDFR,NROW,NOW1,NOW2,NITFR,NWRITE,NOVOP,
1107      ? NOMOP,ELPROP(30,6),PILSTM(30,30)
1108      WRITE(6,528) TIME1
1109      WRITE(6,529) (BCDISP(J,1),J = 1,NDFR)
1110      IF(NOW1.EQ.1) WRITE(6,529)(BCVEL(J,1),J = 1,NDFR)
1111      IF(NOVOP.EQ.1.OR.NOMOP.EQ.1) GO TO 901
1112      GO TO 920
1113      901 DO 910 J = 1,NDFR
1114      UTIL(J,1) = 0.0
1115      DO 910 K = 1,NDFR
1116      910 UTIL(J,1) = UTIL(J,1) + BCDISP(K,1)*PILSTM(J,K)
1117      IF(NOVOP.EQ.1) WRITE(6,529)(UTIL(J,1), J = 1,NDFR)
1118      IF(NOMOP.EQ.0) GO TO 920
1119      SUM = UTIL(1,1)
1120      DO 902 M=2,NDFR
1121      L = M-1
1122      UTIL(M,13) = SUM*ELPROP(L,2) + UTIL(L,13)
1123      902 SUM = SUM + UTIL(M,1)
1124      DO 903 M = 2,NDFR
1125      903 UTIL(M,13) = UTIL(M,13)/12.
1126      WRITE(6,529) (UTIL(J,13), J = 1,NDFR)
1127      920 CONTINUE
1128      528 FORMAT(2X,'TIME = '2E15.6)
1129      529 FORMAT(2X,8F15.6)

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1128 RETURN
1129 END
C
C SUBROUTINE TO WRITE OUTPUT OF RUNGA KUTTA
C
1130 SUBROUTINE OUTPWR
1131 COMMON/CASI/VK(30,30),UTIL(30,30),VM(30,1),BCDISP(30,1),BCVEL(30,1),
1) TIMEI, DELTAT, UPPLIM, NDFR, NROW, NOW1, NOW2, NITER, NWRITE, NOVOP,
2) NOMOP, ELPROP(30,6), PILSTM(30,30)
COMMON/CDEF/ZK(30,4), YK(30,4), TIME, JJ, KKQ, KQUE
1132 TIME = TIME + DELTAT
1133 IF(KQUE.EQ.0) GO TO 226
1134 WRITE(6,528) TIME
1135 WRITE(6,529) (BCDISP(J,1), J = 1, NDFR)
1136 IF(NOW1.EQ.1) WRITE(6,529) (BCVEL(J,1), J=1, NDFR)
1137 IF(NOVOP.EQ.1.OR.NOMOP.EQ.1) GO TO 901
1138 GO TO 920
1139
901 DO 910 J = 1, NDFR
1140 UTIL(J,1) = 0.0
1141 DO 910 K = 1, NDFR
1142 UTIL(J,1) = UTIL(J,1) + BCDISP(K,1)*PILSTM(J,K)
1143 IF(NOVOP.EQ.1) WRITE(6,529) (UTIL(J,1), J = 1, NDFR)
1144 IF(NOMOP.EQ.0) GO TO 920
1145 SUM = UTIL(1,1)
1146 DO 902 M=2, NDFR
1147 L = M-1
1148 UTIL(M,13) = SUM*ELPROP(L,2) + UTIL(L,13)
1149 SUM = SUM + UTIL(M,1)
1150 DO 903 M = 2, NDFR
1151 UTIL(M,13) = UTIL(M,13)/12.
1152 WRITE(6,529) (UTIL(J,13), J = 1, NDFR)
1153
920 CONTINUE
1154 226 CONTINUE
1155 528 FORMAT(2X, 'TIME = '2F15.6)
1156 529 FORMAT(2X, 8E15.6)
1157 RETURN
1158 END
1159

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SDATA

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