Ohsaki's Spectrum—OHSP

The program OHSP (**Oh**saki's **Sp**ectrum) is a subroutine subprogram that calculates the response velocity (spectral velocity) for an arbitrary period to fit the Ohsaki spectrum defined by the control points A, B, C, D, and E in the table below for given the earthquake magnitude, epicentral distance, and damping factor.

Table Coordinates of the control point

Region	Magnitude M	Epocentral Disatance R (km)	Control Point									
			A		B		C		D		E	
			T_A	$(S_v)_A$	T_B	$(S_v)_B$	T_C	$(S_v)_C$	T_D	$(S_v)_D$	T_E	$(S_v)_E$
Short Disatance	6	5	0.02	1.22	0.10	15	0.14	21	0.80	21	2.0	9
	7	10		0.52	0.20	12	0.40	25	1.20	25		20
	8	25		0.28	0.35	4	0.60	30	1.50	30		28
Middle Distance	6	15		0.76	0.12	9	0.25	25	0.65	25		12
	7	45		0.42	0.28	10	0.45	27	0.90	27		24
	8	120		0.30	0.45	10	0.70	33	1.20	33		32
Long Distance	6	60		0.62	0.14	8	0.32	27	0.60	27		15
	7	150		0.46	0.28	11	0.50	32	0.80	32		27
	8	350		0.36	0.50	18	0.70	38	1.00	38		37

OHSP（**Oh**saki's **Sp**ectrum）

【Purpose】

To compute the spectral velocity in the Ohsaki's spectrum for a given period when the magnitude and epicentral distance of an earthquake and the damping factor of the spectrum are specified.

【Usage】

（1） How to connect

```
CALL OHSP(EM, R, H, T, SV, ICALL)
```

Argument	Type	Parameter in calling program	Return Parameter
EM	R	Magnitude of earthquake	Unchanged
R	R	Epicentral distance (unit : km)	Unchanged
H	R	Damping factor in decimal fraction	Unchanged
T	R	Period for calculating velocity spectrum (unit: sec)	Unchanged
SV	R	No need to input here	Spectral velocity (unit: cm/sec)
ICALL	I	ICALL .EQ. 0 : First call ICALL .NE. 1 : Subsequent calls with the same EM, R, H and different T	Unchanged

(2) Necessary subroutines and function subprograms

VELK

【Program List】

```
C  * * * * * * * * * * * * * * * * * * * * *                          OHSP   1
C     SUBROUTINE FOR OHSAKI'S SPECTRUM                                 OHSP   2
C  * * * * * * * * * * * * * * * * * * * * *                          OHSP   3
C                                                                       OHSP   4
C                    CODED BY Y.OHSAKI                                  OHSP   5
C                                                                       OHSP   6
C     PUBPOSE                                                           OHSP   7
C       TO COMPUTE, FOR A GIVEN PERIOD, THE SPECTRL VELOCITY IN         OHSP   8
C       OHSAKI'S SPECTRUM WHEN THE MAGNITUDE AND EPICENTRAL DISTANCE    OHSP   9
C       OF AN EARTHQUAKE AND THE DAMPING FACTOR OF THE SPECTRUM ARE     OHSP  10
C       SPECIFIED                                                       OHSP  11
C                                                                       OHSP  12
C     USAGE                                                             OHSP  13
C       CALL OHSP(EM,R,H,T,SV,ICALL)                                    OHSP  14
C                                                                       OHSP  15
C     DESCRIPTION OF ARGUMENTS                                          OHSP  16
C       EM    - MAGNITUDE                                               OHSP  17
C       R     - EPICENTRAL DISTANCE IN KILOMETERS                       OHSP  18
C       H     - DAMPING FACTOR IN DECIMAL FRACTION                      OHSP  19
C       T     - PERIOD IN SEC                                           OHSP  20
C       SV    - SPECTRAL VELOCITY IN KINES                              OHSP  21
C       ICALL - ICALL.EQ.0 FOR FIRST CALL                               OHSP  22
C               ICALL.NE.0 FOR SUBSEQUENT CALLS WITH THE SAME EM,R,H    OHSP  23
C                          AND DIFFERENT T                              OHSP  24
C                                                                       OHSP  25
C     SUBROUTINES AND FUNCTION SUBPROGRAMS REQUIRED                     OHSP  26
C       VELK                                                            OHSP  27
C                                                                       OHSP  28
```

```
      SUBROUTINE OHSP(EM,R,H,T,SV,ICALL)                                OHSP  29
C                                                                       OHSP  30
      DIMENSION   D(3,3),W(3,3,8),U(3,3,8),UK(8)                        OHSP  31
      EQUIVALENCE (UK(1),TB),(UK(2),TC),(UK(3),TD),(UK(4),SVA),         OHSP  32
     *            (UK(5),SVB),(UK(6),SVC),(UK(7),SVD),(UK(8),SVE)      OHSP  33
      SAVE        UK                                                    OHSP  34
      DATA        D/5.,15.,60.,10.,45.,150.,25.,120.,350./,             OHSP  35
     *            TA/.02/,TE/2./                                        OHSP  36
      DATA        W/0.10,.12,.14,.20,.28,.28,.35,.45,.50,               OHSP  37
     *              0.14,.25,.32,.40,.45,.50,.60,.70,.70,               OHSP  38
     *              0.80,.65,.60,1.2,.90,.80,1.5,1.2,1.0,               OHSP  39
     *              1.22,.76,.62,.52,.42,.46,.28,.30,.36,               OHSP  40
     *               15., 9., 8.,12.,10.,11., 4.,10.,18.,               OHSP  41
     *               21.,25.,27.,25.,27.,32.,30.,33.,38.,               OHSP  42
     *               21.,25.,27.,25.,27.,32.,30.,33.,38.,               OHSP  43
     *                9.,12.,15.,20.,24.,27.,28.,32.,37./               OHSP  44
C                                                                       OHSP  45
C     INITIALIZATION                                                    OHSP  46
C                                                                       OHSP  47
      IF(ICALL.NE.0) GO TO 210                                          OHSP  48
      DO 130 K=1,8                                                      OHSP  49
      DO 120 J=1,3                                                      OHSP  50
      DO 110 I=1,3                                                      OHSP  51
      U(I,J,K)=W(I,J,K)                                                 OHSP  52
  110 CONTINUE                                                          OHSP  53
  120 CONTINUE                                                          OHSP  54
  130 CONTINUE                                                          OHSP  55
C                                                                       OHSP  56
C     EFFECT OF DAMPING FACTOR                                          OHSP  57
C                                                                       OHSP  58
      T0=10.**(0.31*EM-1.2)                                             OHSP  59
      DO 160 K=5,8                                                      OHSP  60
      DO 150 J=1,3                                                      OHSP  61
      DO 140 I=1,3                                                      OHSP  62
      U(I,J,K)=U(I,J,K)/SQRT(1.+17.*(H-0.05)*EXP(-2.5*U(I,J,K-4)/T0))   OHSP  63
  140 CONTINUE                                                          OHSP  64
  150 CONTINUE                                                          OHSP  65
  160 CONTINUE                                                          OHSP  66
C                                                                       OHSP  67
C     INTERPOLATION                                                     OHSP  68
C                                                                       OHSP  69
      J=INT((EM+0.0001)/7.)+1                                           OHSP  70
      EMR=EM-REAL(J+5)                                                  OHSP  71
      R1=ALOG(D(2,J+1))*EMR+ALOG(D(2,J))*(1.-EMR)                       OHSP  72
      RLOG=ALOG(R)                                                      OHSP  73
      IF(RLOG-R1) 170,180,180                                           OHSP  74
  170 I=1                                                               OHSP  75
      R2=R1                                                             OHSP  76
      R1=ALOG(D(1,J+1))*EMR+ALOG(D(1,J))*(1.-EMR)                       OHSP  77
      GO TO 190                                                         OHSP  78
  180 I=2                                                               OHSP  79
      R2=ALOG(D(3,J+1))*EMR+ALOG(D(3,J))*(1.-EMR)                       OHSP  80
  190 RR=(RLOG-R1)/(R2-R1)                                              OHSP  81
```

```
      IF(RR.LT.0.) RR=0.                                              OHSP  82
      VMULT=VELK(EM,R)/10.                                            OHSP  83
      DO 200 K=1,8                                                    OHSP  84
      U1=ALOG(U(I,J+1,K))*EMR+ALOG(U(I,J,K))*(1.-EMR)                 OHSP  85
      U2=ALOG(U(I+1,J+1,K))*EMR+ALOG(U(I+1,J,K))*(1.-EMR)             OHSP  86
      UK(K)=EXP(U2*RR+U1*(1.-RR))                                     OHSP  87
      IF(K.LE.3) GO TO 200                                            OHSP  88
      UK(K)=UK(K)*VMULT                                               OHSP  89
  200 CONTINUE                                                        OHSP  90
C                                                                     OHSP  91
C     SPECTRAL VELOCITY FOR GIVEN PERIOD                              OHSP  92
C                                                                     OHSP  93
  210 IF(T.GT.TA) GO TO 220                                           OHSP  94
      SV=T/TA*SVA                                                     OHSP  95
      RETURN                                                          OHSP  96
  220 IF(T.GE.TB) GO TO 230                                           OHSP  97
      SV=T*(SVA/TA+(T-TA)/(TB-TA)*(SVB/TB-SVA/TA))                    OHSP  98
      RETURN                                                          OHSP  99
  230 IF(T.GE.TC) GO TO 240                                           OHSP 100
      SV=T*(SVB/TB+(T-TB)/(TC-TB)*(SVC/TC-SVB/TB))                    OHSP 101
      RETURN                                                          OHSP 102
  240 IF(T.GE.TD) GO TO 250                                           OHSP 103
      SV=EXP(ALOG(SVC)+ALOG(T/TC)/ALOG(TD/TC)*ALOG(SVD/SVC))          OHSP 104
      RETURN                                                          OHSP 105
  250 SV=EXP(ALOG(SVD)+ALOG(T/TD)/ALOG(TE/TD)*ALOG(SVE/SVD))          OHSP 106
      RETURN                                                          OHSP 107
      END                                                             OHSP 108
```

【Example】

Calculate the Ohsaki's spectrum with a damping factor of 5% for an earthquake of magnitude 7.3 with an epicentral distance of 25.0 km.

```
C
      DIMENSION T(51),SV(51)
      DATA  N/51/,EM/7.3/,R/25.0/,H/0.05/
C
      Q=ALOG(0.02)
      P=(ALOG(2.0)-Q)/REAL(N-1)
      DO 110 I=1,N
      T(I)=EXP(REAL(I-1)*P+Q)
      CALL OHSP(EM,R,H,T(I),SV(I),I-1)
  110 CONTINUE
      STOP
C
  601 FORMAT(F10.3,2X,F12.3 )
      END
```

Output: Calculate the spectral velocity for a period (stored in the array *T*) that divides logarithmically into 50 equal parts between 0.02 and 2 sec. The computed Ohsaki's spectrum is shown in the following figure.