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# NONLINEAR RESPONSE SPECTRA FOR PROBABILISTIC SEISMIC DESIGN AND DAMAGE ASSESSMENT OF REINFORCED CONCRETE STRUCTURES

by

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by

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#### ABSTRACT

In the investigation reported herein, twenty each of five different types of artificial earthquake accelerograms were generated for computing nonlinear response spectra of five structural models representing reinforced concrete buildings. To serve as a basis for probabilistic design and damage assessment, mean values and standard deviations of ductility factors were determined for each model having a range of prescribed strength values and having a range of natural periods. Adopting the standard philosophy, i.e. only minor damage is acceptable under moderate earthquake conditions and total damage or complete failure should be avoided under severe earthquake conditions, required strength levels were investigated for each model. Selected results obtained in the overall investigation are presented and interpreted in terms of prototype behavior.

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#### I. INTRODUCTION

The general philosophy of seismic resistant design in most countries of the world, including Japan and the United States, is that only minor damage is acceptable in buildings subjected to moderate earthquake conditions and that total damage or complete failure should be prevented under severe earthquake conditions. This philosophy serves as the basic criterion for assessing the potential seismic performance of existing buildings and for defining design criteria for new buildings.

Usually, the above philosophy is applied to performance assessments and to design in a deterministic manner. In this case, seismic response analyses are carried out for fixed mathematical models using fully prescribed ground motion excitations. It should be realized however that many uncertainties exist in this method. The highly variable characteristics of ground motions, even for a given site, is the major cause of these uncertainties. However, other causes also exist such as the variability of structural properties. For this reason, nondeterministic methods which formally recognize uncertainties and which predict response in probabilistic terms should be encouraged. Meanwhile every effort should be made to reduce the uncertainties through experimental and analytical research and through improved design and construction methods.

To carry out nondeterministic seismic analyses, an appropriate stochastic model must be established for the expected ground motions. If sufficient strong ground motion data were available this model could be obtained by direct statistical analyses. However, due to the limited data available, one is forced to hypothesize model forms and to use the existing data primarily in checking the appropriateness of these forms. The particular model used in this investigation is essentially

nonstationary filtered white noise as commonly used by many investigators [1,2]. While this model is admittedly not perfect, it does reflect the main statistical features of real ground motions; therefore, its use in seismic response analyses leads to more realistic predictions than does a single fully prescribed accelerogram.

Since it was the intent of this investigation to concentrate on low-rise reinforced concrete buildings, two basic single degree of freedom structural models were selected for dynamic analysis purposes, namely, the so called "Origin-Oriented Model" and the "Trilinear Stiffness Degrading Model" [3]. These models were selected to represent structures which fail primarily in shear and flexure, respectively. Various strength values were prescribed for these models and their initial stiffnesses were varied to produce a wide range of fundamental periods.

Mean values and standard deviations of ductility factor were generated using the five different classes of earthquake accelerograms for each structural model having a prescribed period and assigned strength values. These statistical quantities can be used as the basis for probabilistic design and damage assessment.

Accepting the basic philosophy previously mentioned, namely that only minor damage is acceptable under moderate earthquake conditions and that total damage or complete failure should be avoided under severe conditions, Umemura has proposed a basic criterion for seismic design which has been adopted herein [3]. This criterion has been used in probabilistic terms to establish appropriate strength levels for each model consistent with the basic design philosophy.

A computer program which generates artiticial earthquake accelerograms and nonlinear response spectra is presented in Appendix A.

#### II. GENERATION OF ARTIFICIAL EARTHQUAKE ACCELEROGRAMS

#### 2.1 STOCHASTIC MODELS

Two basic types of nonstationary processes are commonly used to represent earthquake ground motions, namely, nonstationary filtered white noise and filtered shot noise [1,4,5]. Shinozuka and Sato suggest that under similar conditions both types lead to essentially the same response characteristics of linear systems [6].

In the present investigation, five specific types (Types A, B,  $B_{0,2}$ , C, and D) of artificial accelerograms were generated using the second of the above mentioned basic types. The computer program used for this purpose was a modified version of the program (PSEQGN) developed by Ruiz. It follows a procedure consisting of five phases, (1) stationary wave forms are generated having a constant power spectral density function (white noise) of intensity  $S_{o}$  over a wide range of frequencies starting at zero frequency, (2) nonstationary shot noise is next obtained by multiplying each stationary wave form by a prescribed time intensity function, (3) each of the resulting wave forms of shot noise is then passed through a second-order filter which amplifies the frequency content in the neighborhood of a characteristic frequency and attenuates the higher frequencies, (4) next each of these filtered wave forms is passed through a second second-order filter which eliminates the very low frequency content, and finally (5) a baseline correction is applied to the double filtered accelerograms in accordance with the procedure of Berg and Housner [7]. Both second-order filterings are accomplished digitally by solving numerically the second-order differential equations relating filter outputs to their corresponding inputs [8]. These

solutions are obtained numerically by the standard linear acceleration method using constant integration time intervals of 0.01 seconds. By this procedure, final accelerograms are obtained in digitized form with each having similar 0.01 second time intervals.

#### 2.2 TIME INTENSITY FUNCTIONS

Five classes of earthquake accelerograms (Types A, B,  $B_{02}$ , C and D) were generated using four different time intensity functions as shown in Fig. 1. These intensity functions are the same as those used previously by Jennings, et al [2]. Note that accelerograms of Types B and  $B_{02}$  were generated using the same intensity function. All four intensity functions consist of three phases (1) a parabolic or cubic build-up phase, (2) a constant intensity phase, and (3) an exponential decay phase. The total durations of these particular functions are 120, 50, 12 and 10 seconds, respectively; however, since the ends of the decay phase do not affect maximum response of damped structural systems, they were cut off at 75, 30, 10 and 5 seconds for Types A, B, C and D, respectively.

#### 2.3 HIGH FREQUENCY FILTER CHARACTERISTICS

As previously stated, the nonstationary shot noise wave forms were obtained by multiplying each stationary wave form having a power spectral intensity S by a prescribed time intensity function.

The high frequency filtering procedure was then used to shape the frequency content of the shot noise wave forms using the transfer function (complex frequency response function [8])

$$H_{1}(i\omega) = \frac{[1 + (4 \xi^{2} - 1) (\omega/\omega_{0})^{2}] - 2i \xi_{0} (\omega/\omega_{0})^{3}}{[1 - (\omega/\omega_{0})^{2}]^{2} + 4 \xi_{0}^{2} (\omega/\omega_{0})^{2}}$$
(1)

This transfer function, previously suggested by Kanai and Tajimi for this purpose [9,10], is usually written in the more familiar form

$$|H_{1}(i\omega)|^{2} = \frac{1 + 4 \xi_{0}^{2}(\omega/\omega_{0})^{2}}{[1 - (\omega/\omega_{0})^{2}]^{2} + 4 \xi_{0}^{2}(\omega/\omega_{0})^{2}}$$
(2)

Jennings, Ruiz, and other investigators have also used this same transfer function.

Parameters  $\omega_{0}$  and  $\xi_{0}$  appearing in the above filter function may be thought of as some characteristic ground frequency and damping ratio, respectively. Kanai has suggested 15.6 rad/sec for  $\omega_{0}$  and 0.6 for  $\xi_{0}$  as representative values for firm soil conditions. The frequency transfer function in the form of Eq. (2) is plotted in Fig. 2a for  $\xi_{0} = 0.6$ . These same values of  $\omega_{0}$  and  $\xi_{0}$  were used in the present investigation for four of the five classes of accelerograms, namely, Types A, B, C, and D. Accelerograms of Type B<sub>02</sub> used the same value for  $\omega_{0}$ , i.e. 15.6 rad/sec., but a different value for  $\xi_{0}$ , namely, 0.2. This damping value was selected for Type B<sub>02</sub> accelerograms to study the influence of a relatively narrow band excitation on structural response.

#### 2.4 LOW FREQUENCY FILTER CHARACTERISTICS

The low frequency filter used in this investigation had the transfer function [2,8]

$$H_{2}(i\omega) = \frac{(\omega/\omega_{f})^{2}[1 - (\omega/\omega_{f})^{2}] - 2i \xi_{f}(\omega/\omega_{f})^{3}}{[1 - (\omega/\omega_{f})^{2}]^{2} + 4 \xi_{f}^{2} (\omega/\omega_{f})^{2}}$$
(3)

or

$$|H_{2}(i\omega)|^{2} = \frac{(\omega/\omega_{f})^{4}}{[1 - (\omega/\omega_{f})^{2}]^{2} + 4\xi_{f}^{2}(\omega/\omega_{f})^{2}}$$
(4)

where  $\omega_{\rm f}$  and  $\xi_{\rm f}$  are the characteristic frequency and characteristic damping ratio, respectively, for the filter. The damping ratio term  $\xi_{\rm f}$  was assigned the numerical value  $1/\sqrt{2}$  which reduces Eq. (4) to

$$\left|H_{2}(i\omega)\right|^{2} = \frac{(\omega/\omega_{f})^{4}}{1 + (\omega/\omega_{f})^{4}}$$
(5)

Introducing the period ratio  $T/T_f$ , where  $T = 2\pi/\omega$  and  $T_f = 2\pi/\omega_f$ , Eq. (5) becomes

$$|H_2(iT)|^2 = \frac{1}{1 + (T/T_f)^4}$$
 (6)

In this investigation,  $T_{f}$  equals 7 and 2 seconds for Types A, B and  $B_{02}$  and for Types C and D, respectively. The square root of the function given by Eq. (6) is shown in Fig. 2b.

#### 2.5 DISCUSSION ON ARTIFICIAL ACCELEROGRAMS

The constant power spectral intensity  $S_o$ , used in generating the stationary wave forms, was assigned the value 0.08952 ft<sup>2</sup>/sec<sup>3</sup>. Using a family of 20 Type B accelerograms, this intensity resulted in a mean peak acceleration of 0.300g with a standard deviation of 0.032g. Increasing the number of accelerograms to 40 gave a mean peak acceleration of 0.308g and a standard deviation of 0.037g. Following the method of Gumbel [11], it is estimated that for an infinite number of similar accelerograms, the mean peak acceleration would be 0.309g and the standard deviation would be 0.041g. Therefore, in view of this mean peak acceleration and the time intensity function used, the Type B accelerograms closely represent that class of motions containing the N-S component of acceleration recorded during the 1940 El Centro, California, earthquake [2,4]. Table 1 lists the mean values and standard deviations for the peak accelerations in all 5 classes of accelerograms, i.e. for Types A, B, C, D, and  $B_{02}$ . In obtaining these results,  $S_0$  was assigned the same value 0.08952 ft<sup>2</sup>/sec<sup>3</sup> in each case. Notice that the mean peak acceleration decreases as the duration of the constant intensity phase in the motion decreases. This observation is, of course, consistent with the theory of extreme values. Notice also that the standard deviations are relatively small in each case.

Following the suggestion of Jennings, et. al. [2], the Type A accelerograms are intended to represent the upper bound ground motions expected in the vicinity of the causative fault during an earthquake having a Richter Magnitude 8 or greater. The Type B accelerograms are intended to represent the motions close to the fault in a Magnitude 7 earthquake, such as the 1940 El Centro, California, earthquake and the 1952 Taft, California, earthquake. The Type C accelerograms are intended to represent the ground motions in the epicentral region of a Magnitude 5.5 shock, such as occurred during the 1957 San Francisco earthquake, and the Type D accelerograms are intended to represent the motions present in the immediate vicinity of the fault of a 4.5 to 5.5 Magnitude earthquake having a small focal depth, such as the 1966 Parkfield, California, earthquake. If the artificial accelerograms generated as Types A, B, C, and D are indeed to be representative of these conditions, then each class of motions should be normalized by the appropriate factors to raise the mean peak acceleration levels from 0.332q, 0.309q, 0.244q, and 0.189g, respectively, to approximately 0.45g, 0.33g, 0.10g, and 0.50g.

Since the extreme values of response for all 5 structural models used in this investigation were measured in terms of ductility factors, the above mentioned normalization of accelerograms is not required. These

ductility factors are controlled by a structural model strength to ground motion intensity ratio; i.e.  $p_s/mv_{go}$  where  $p_s$  is the significant structural strength parameter, m is the mass of the single degree of freedom system, and  $\ddot{v}_{go}$  is the mean peak acceleration. Allowing this ratio to vary over a prescribed range of values is equivalent to allowing  $p_s$  and/or  $\ddot{v}_{go}$  to vary independently over restricted ranges.

Further, it should be recognized that the structural response data generated for ground motions of Types A, B, C, D and  $B_{02}$  can be interpreted in terms of structural response to other classes of motions. For example, suppose one wished to interpret these response data for similar classes of earthquake motions but for a change in the characteristic ground frequency  $\omega_{0}$  to reflect a change in soil conditions. This interpretation can be accomplished by considering a change in the time scale of the accelerograms; thus, forcing corresponding changes in the time intensity functions, the value of  $T_{f}$ , the value of  $\omega_{o}$ , and the mean peak acceleration. Since the value of S representing the new classes of accelerograms is to remain unchanged, the mean peak accelerations of the new motions will be changed exactly in proportion to the square root of the ratio of the original time interval to the new time interval. Specifically, suppose the time interval is considered to be changed from 0.01 sec. to 0.005 sec. for the Type A accelerograms. In this case, the total duration (as represented by OC, Fig. 1) is reduced from 75 sec. to 37.5 sec.,  $\omega_{\rm o}$  is increased from 15.6 rad/sec. to 31.2 rad/sec.,  $\rm T_{f}$  is reduced from 7 sec. to 3.5 sec., and the mean peak acceleration is increased from 0.33g to 0.46g ( $\sqrt{2} \cdot 0.33 = 0.46$ ).

#### III. STRUCTURAL HYSTERETIC MODELS

#### 3.1 BASIC PARAMETERS OF MODELS

The single degree of freedom system shown in Fig. 3a was used as the basic form for all structural models investigated. This model has a linear viscous dashpot but a nonlinear hysteretic spring. The restoring spring force is therefore some prescribed nonlinear function F(v)of the relative displacement v(t). The principal quantities used to characterize this function are  $p_c$ ,  $p_y$ ,  $v_c$ , and  $v_y$  as shown in Fig. 3b. Loads  $p_c$  and  $p_y$  represent the spring restoring forces corresponding to the concrete cracking strength and the ultimate strength, respectively. Displacements  $v_c$  and  $v_y$  are the corresponding relative displacements.

#### 3.2 ORIGIN-ORIENTED SHEAR MODEL

One of the five structural models used in this investigation was the so-called "Origin-Oriented" hysteretic model proposed by Umemura, et. al. [3]. This model is shown in Fig. 4 where it is characterized by  $p_{sc}$ ,  $p_{sy}$ ,  $v_{sc}$ , and  $v_{sy}$  which represent the concrete shear cracking strength, the ultimate shear strength, the relative displacement produced by  $p_{sc}$ , and the relative displacement produced by  $p_{sy}$ , respectively. Application of this model is restricted to those structural types where the nonlinear deformations and failure characteristics are controlled primarily by shear.

This model is defined such that the hysteretic behavior takes place with increasing relative displacements greater than  $v_{sc}$  or decreasing displacements less than  $-v_{sc}$ . Reduction of loads from values greater than  $p_{sc}$  or less than  $-p_{sc}$  follow linear paths always directed through the origin, e.g. paths A'O and A"O in Fig. 4. Oscillatory motions can, of course, take place along the linear paths such as A'OA' and A"OA" without developing hysteretic loops provided the maximum displacements do not exceed the maximum displacement previously developed. The particular model plotted in Fig. 4 is for the case where  $p_{sy} = 1.9 p_{sc}$ ,  $v_{sy} = 10.0 v_{sc}$ ,  $k_2 = 0.1 k_1$ , and  $k_3 = 0.19 k_1$ .

#### 3.3 TRILINEAR STIFFNESS DEGRADING FLEXURE MODEL

Four of the five structural models used in this investigation were the so-called "Trilinear Stiffness Degrading" hysteretic model [3]. This model is shown in Fig. 5 where it is characterized by  $p_{Bc}$ ,  $p_{By}$ ,  $v_{Bc}$ , and  $v_{By}$  which represent the load at which the concrete cracks due to flexure, the load at which the main reinforcing steel starts yielding due to flexure, the relative displacement produced by  $p_{Bc}$ , and the relative displacement produced by  $p_{By}$ , respectively. Application of this model is restricted to those structural types where the nonlinear deformations and failure characteristics are primarily controlled by flexure.

The trilinear model is defined such that linear elastic behavior (without hysteretic loops) always takes place for oscillatory displacements where the corresponding oscillator loads are in the range  $-p_{BC}^{}$  <  $p < p_{BC}$ ; however, hysteretic behavior occurs with every cycle of deformation which has load levels above p or below -p . During that period of time between the initiation of loading and that instant at which the relative displacement first increases above  $v_{BV}$  or decreases below  $-v_{By}$ , the trilinear model behaves exactly like the standard bilinear hysteretic model having stiffnesses  $k_1$  and  $k_2$  (QPOAB; Fig. 5a). However, as soon as the relative displacement increases above v<sub>Bv</sub> or decreases below -v<sub>Bv</sub>, a new bilinear hysteretic relation controls the response. For example, suppose the relative displacement for the first time increases above  $v_{By}$  to level  $v_{max}$  as represented by C in Fig. 5a. Upon decreasing the displacement from this level, the corresponding load decreases along path CD which has a slope equal to  $\alpha k_1$ , where

$$\alpha \equiv \frac{2 v_{By}}{v_{max} + v_{By}}$$
(7)

As soon as the load drops by the amount  $2p_{Bc}$  reaching point D in Fig. 5a, any further drop in load will follow the continuing path shown having a slope  $\alpha k_2$ . It should be noted that point D is located at load level  $p_{Bc}$  in Fig. 5a but only because the particular trilinear model represented in that figure is for  $p_{By}/p_{Bc} = 3.0$ . If this ratio had been assigned a different numerical value, the load level at point D would be different from  $p_{Bc}$ .

The new bilinear hysteretic model controlling the continuing motion is shown in Fig. 5b. Note that the origin of the skelton curve is shifted from point 0, the origin of the original bilinear hysteretic model, to point 0'. This point is the intersection point of line QC and the abscissa axis in Fig. 5a; therefore 00' is equal to BC/2. The stiffnesses of the new bilinear model are  $\alpha k_1$ , and  $\alpha k_2$ .

If during the period of response controlled by the second bilinear model (Fig. 5b) the relative displacement should increase beyond  $v_{max}$  ( $v_{max} = v_{By}$ ,) as represented by point B' to a new level as represented by C', the continuing response would be controlled by a third bilinear hysteretic model whose characteristics could be obtained in exactly the same manner as the characteristics of the second model. Also, if yielding of the trilinear model had taken place at load level  $-p_{By}$  rather than load level  $p_{By}$ , the new bilinear model controlling the continuing motion would be obtained by a similar procedure.

One characteristic feature of the trilinear stiffness degrading model worth noting is that when subjected to full-reversal cyclic displacements at a constant amplitude the bilinear hysteretic loops are perfectly stable, i.e. each loop retraces the preceding one. The energy absorbed during each successive cycle must therefore be equal. Using a period  $T_2 = 2\pi \sqrt{m/k_y}$ , where  $k_y$  is an average stiffness as shown in Fig. 6, one can calculate the equivalent damping ratio  $\xi$  for a linear viscously-damped single degree system which represents the same energy absorption per cycle of oscillation. This damping ratio is shown in Fig. 6 for each of four different bilinear models.

#### IV. SELECTION OF MODEL PARAMETERS

#### 4.1 ORIGIN-ORIENTED SHEAR MODEL

As previously defined, the origin-oriented hysteretic model shown in Fig. 4 is completely characterized by any four of the seven parameters  $k_1$ ,  $k_2$ ,  $k_3$ ,  $p_{sc}$ ,  $p_{sy}$ ,  $v_{sc}$ ,  $v_{sy}$ . Based on experimental data [3], it has been determined that

$$p_{sv} \doteq 1.9 p_{sc}$$
(8)

$$v_{sy} \doteq 10 v_{sc}$$
 (9)

which reduces the number of independent parameters to two. It is most meaningful to let one of these two parameters be a stiffness parameter and the other be a strength parameter. For this purpose, it is convenient to use period  $T_1 = 2\pi \sqrt{m/k_1}$  and the concrete cracking force  $p_{sc}$ . As shown later,  $p_{sc}$  is normalized by the force  $m\bar{v}_{go}$ , where  $\bar{v}_{go}$  is the mean peak ground acceleration.

#### 4.2 TRILINEAR STIFFNESS DEGRADING FLEXURE MODEL

The general trilinear stiffness degrading hysteretic model shown in Fig. 5 is completely characterized by any four of the seven parameters  $k_1$ ,  $k_2$ ,  $k_y$ ,  $p_{Bc}$ ,  $p_{By}$ ,  $v_{Bc}$ ,  $v_{By}$ . Four specific models, which were previously studied by other investigators [3], were selected for this investigation,

1. 
$$k_1 = 2k_y$$
;  $p_{By} = 3p_{Bc}$   
2.  $k_1 = 2k_y$ ;  $p_{By} = 2p_{Bc}$   
3.  $k_1 = 4k_y$ ;  $p_{By} = 3p_{Bc}$   
4.  $k_1 = 4k_y$ ;  $p_{By} = 2p_{Bc}$   
(10)

These four models were chosen because  $k_y$  and  $p_{By}$  are often found in the ranges  $2k_y < k_1 < 4k_y$  and  $2p_{Bc} < p_{By} < 3p_{Bc}$ , respectively, for reinforced concrete members. For frame structures, these ranges are not so well defined so that engineering judgment must be relied upon in assigning values consistent with their overall nonlinear behaviors.

Having assigned numerical values to the ratios  $k_y/k_1$  and  $p_{By}/p_{Bc}$ , only two independent model parameters remain. In this case it is most convenient to select a stiffness parameter measured in terms of  $T_1 = 2\pi \sqrt{m/k_1}$  and a strength parameter measured in terms of  $p_{By}$ . Again, the strength parameter selected  $(p_{By})$  is normalized by the force m  $\ddot{v}_{go}$ .

#### 4.3 VISCOUS DAMPING MODEL

As shown in Fig. 3a, the single degree of freedom model used in this investigation included a linear viscous dashpot having a variable coefficient c. The coefficient used with the origin-oriented shear model is defined by the relation  $c(t) = 2 \xi_1 k(t)/\omega(t)$  where  $\xi_1$  is a constant damping ratio, and k(t) and  $\omega(t)$  are variable stiffness and natural circular frequency in accordance with the stiffness at time t, respectively. The coefficient used with the trilinear stiffness degrading flexure model is defined by the relation  $c(t) = 2 \xi_1 k(t)/\omega_1$  where  $\omega_1$  is a initial natural circular frequency. This coefficient becomes smaller with a reduction or degradation of stiffness.

#### V. DYNAMIC RESPONSE ANALYSIS

The complete time history of dynamic response was generated for the single degree of freedom system using the five different structural models subjected seperately to the twenty artificially generated earthquake ground motions. The equation of motion governing this response is the well known relation

$$\ddot{w}(t) + c(t)\dot{v}(t) + F(v) = -m\ddot{v}_{g}(t)$$
 (11)

where F(v) is the nonlinear spring force defined by the hysteretic model being considered; i.e. the spring force defined by either Fig. 4 or Fig. 5. Dividing through by  $mv_{\sigma O}$  (a constant) gives

$$\begin{bmatrix} \frac{1}{\ddot{v}} \\ \ddot{v}_{go} \end{bmatrix} \ddot{v}(t) + \begin{bmatrix} \frac{c(t)}{\ddot{\pi}} \\ m \ddot{v}_{go} \end{bmatrix} \dot{v}(t) + \frac{F(v)}{\ddot{\pi}} = - \frac{v_{g}(t)}{\ddot{\pi}}$$
(12)

Note that the third term on the left hand side of this equation is the same force-displacement relation defined by the hysteretic model but with the force normalized (as previously mentioned) by the constant  $m \ddot{v}_{go}$ . Knowing the numerical values assigned to constants  $\ddot{v}_{go}$ ,  $\xi_1$ , and  $T_1$ , as well as the prescribed value of  $p_{sc}/m \ddot{v}_{go}$  (or  $p_{By}/m \ddot{v}_{go}$ ), one can solve Eq. (12) for the complete time history of response v(t). This solution is obtained numerically using the standard "linear acceleration" method. The time interval  $\Delta t$  generally used in the integration was shortened to a subdivided value  $\Delta t'$  during short periods of time in which the model stiffness changed value. The numerical values of  $\Delta t$  and  $\Delta t'$  used for four different ranges of period  $T_1$ , are shown in Table 2.

The response quantity of primary interest is the ductility factor  $\mu$  which is defined as  $v(t)_{max}/v_{sc}$  for the origin-oriented model and as  $v(t)_{max}/v_{By}$  for the trilinear stiffness degrading model. This factor was obtained for each of the five structural models when subjected separately to each of the 20 ground motions generated for Types A, B, C, D, and  $B_{02}$ . The damping ratio  $\xi_1$  was assigned the value 0.05 for the origin-oriented model and 0.02 for the trilinear stiffness degrading model. Since the ductility factor was desired for a range of stiffnesses, period  $T_1$  was assigned 10 different numerical values as given by

$$T_1 = 0.1(2)^{n/2} (n = 0, 1, 2, ..., 9)$$
 (13)

Using the origin-oriented model, ductility factors were obtained for a range of values of  $p_{sc}/m \ \ddot{\ddot{v}}_{go}$ , namely 0.50, 0.75, 1.00, 1.25, 1.50, 1.75, 2.00, 2.25, 2.50, and 3.00. Using the trilinear stiffness degrading model, these values were obtained for  $p_{By}/m \ \ddot{\ddot{v}}_{go}$ equal to 0.50, 0.75, 1.00, 1.125, 1.25, 1.50, and 1.75.

#### 6.1 LINEAR ELASTIC MODEL

To characterize the five classes of earthquake motions (Types A, B, C, D, and  $B_{02}$ ) in most familiar terms, all 20 accelerograms of each type were seperately used as the excitation applied to a linear, viscously damped ( $\xi = 0.05$ ) single degree of freedom system. Mean absolute acceleration response ratios  $\alpha$  as defined by

$$\alpha \equiv \frac{\bar{v}^{t}(t)_{max}}{\bar{v}_{go}}$$
(14)

, where  $\vec{\ddot{v}}^{t}(t)_{max}$  is the mean value of 20 maximum absolute accelerations  $[\vec{v}^{t}(t)_{max}]$  and where  $\vec{\ddot{v}}_{go}$  is the peak mean value of ground accelerations, were determined for each excitation over a range of periods T. The coefficients of variation (ratio of standard deviation to mean value) of  $\vec{v}^{t}(t)_{max}$  were also determined for the 20 accelerograms in each type of excitation.

The results of the analyses for all five classes of earthquake are shown in Fig. 7 where the mean absolute acceleration response ratios  $\alpha$  and the coefficients of variation of  $\ddot{v}^{t}(t)_{max}$  are plotted as functions of period T. As would be expected, the values of  $\alpha$  for the five classes of earthquakes are widely seperated at the long period end of the abscissa scale but converge together towards the low period end of the scale. As the period goes to zero,  $\alpha$  must of course, approach unity. It is seen in Fig. 7 (excluding Type  $B_{02}$ ) that  $\alpha$  increases with duration of the earthquake excitation. The very high peak shown in the function of  $\alpha$  for Type  $B_{02}$  is caused by the narrow band excitation in the ground motion in the neighborhood of T = 0.4 sec. The coefficients of variation of  $\ddot{v}^{t}(t)_{max}$  decrease with duration of excitation and increase generally with period T. It should be recognized that as T approaches zero the coefficients of variation of  $\ddot{v}^{t}(t)_{max}$  approach the corresponding coefficients of variation of  $\ddot{v}_{go}(t)_{max}$ , as given in Table 1.

#### 6.2 ORIGIN-ORIENTED SHEAR MODEL

Mean ductility factors  $\bar{\mu}$  and their corresponding coefficients of variation were generated for the origin-oriented shear model using the 20 response time histories for each class of earthquake ground motions. Values, as obtained over the period range  $0.1 < T_1 < 1.6 \sqrt{2}$  and over the normalized load range  $0.50 < \beta_s < 3.00$  (where  $\beta_s$  is defined as the ratio  $p_c/m \ \bar{\bar{\nu}}_{go}$ ), are shown in Figs. 8a-8e. For each type of earthquake, these ductility factors generally increase with decreasing period and the spread of ductility factors over the full strength range increases with decreasing period. Also the ductility factors for a fixed period increases with decreasing structural strength.

The trends of the coefficients of variation with period are similar to those previously described for mean ductility factor, particularly regarding strength level and strength variation. It is most significant to note that the coefficients of variation are low when the response is essentially elastic ( $\mu$  < 1) but they can become very large with increasing inelastic deformations.

When interpreting the results in Figs. 8a-8e, it should be noted that the strength ratio  $\beta_s \equiv p_c/m \ \ddot{\ddot{v}}_{go}$  can be expressed in the form

$$\beta_{\rm s} = (p_{\rm c}/W)/(\ddot{v}_{\rm go}/g)$$
(15)

where W is the weight of the single degree of freedom mass and g is the acceleration of gravity. Therefore, this parameter can be considered as the ratio of base shear to coefficient of mean peak ground acceleration.

If for any particular case one wishes to determine the mean maximum relative displacement  $\bar{v}(t)_{max}$ , this can be accomplished by using the appropriate mean ductility factor  $\bar{\mu}$  taken from Figs. 8a-8e. By definition of ductility factor, one can state

$$\bar{v}(t)_{max} = v_{c} \bar{\mu} = (p_{c}/k_{1}) \bar{\mu}$$
 (16)

Making use of the definition of  $\beta_{s}$  given above, this equation can be written in the form

$$\overline{v}(t)_{\max} = \frac{m}{k_1} \beta_s \overline{\mu} \overline{v}_{go}$$
(17)

or

$$\overline{v}(t)_{max} = T_1^2 \beta_s \overline{\mu} \left[ \frac{g}{4\pi^2} \right] \left[ \frac{\overline{v}_{go}}{g} \right]$$
 (18)

Equation (18) is the most convenient form for calculating  $\bar{v}(t)_{max}$ .

#### 6.3 TRILINEAR STIFFNESS DEGRADING FLEXURE MODEL

Mean ductility factors and their corresponding coefficients of variation were generated for the four trilinear stiffness degrading flexure models using the 20 response time-histories for each class of earthquake ground motions. Values, as obtained over the period range  $0.1 < T_1 < 1.6 \sqrt{2}$  and over the normalized load range  $0.50 < \beta_f < 1.75$  (where  $\beta_f$  is defined as the ratio  $p_y/m \ddot{\bar{v}}_{go}$ ), are shown in Figs. 9a-9d, 10a-10d, 11a-11d, 12a-12d, and 13a-13d for earthquake Types A, B, C, D, and  $B_{02}$ , respectively.

The general trends of these results are very similar to those previously described for the origin-oriented shear model. It is worth pointing out again that the coefficients of variation of maximum response are relatively low for cases of essentially elastic behavior but can become very large for cases involving inelastic deformations.

As in the case of the origin-oriented model, mean maximum response can be calculated using the relation

$$\bar{\mathbf{v}}(t)_{\max} = \mathbf{T}_2^2 \beta_f \bar{\mu} \left[ \frac{g}{4\pi^2} \right] \left[ \frac{\bar{\mathbf{v}}_{go}}{g} \right]$$
(19)

#### VII. USE OF DUCTILITY RESPONSE SPECTRA FOR PROBABILISTIC SEISMIC DESIGN

### 7.1 SELECTION OF REQUIRED DUCTILITY LEVELS

It is implied in the basic philosophy of design previously stated that economical considerations do not permit the design of structures for zero risk of damage in high seismic regions. To minimize total costs (initial costs, repair costs after earthquakes, etc.), damage is often permitted to limited degrees under moderate to severe earthquake conditions. It should be understood that permitting some damage to occur in a well designed structure has the beneficial effect of limiting damage to that same structure. This is due to the fact that the energy absorption associated with damage is effective in limiting the maximum levels of oscillatory motion in the strucuture. Therefore, a good seismic resistant structure should be designed for high energy absorption capacity assuming it will experience controlled damage under severe to moderate earthquake conditions. In terms of the hysteretic structural models presented herein, this concept means that the ductility factor should be limited to certain values consistent with the basic design philosophy.

Assume for the moment that one prescribes two numerical values of ductility factor for a given structural model. The smaller value was chosen to be consistent with light damage under moderate earthquake conditions and the large value was chosen to be consistent with heavy damage (but not complete failure) under severe conditions. Two questions come to mind (1) "What is the probability of these ductility factors being exceeded during a single earthquake of Types A, B, C, D, or  $B_{02}$ ?" and (2) "What ductility factors are required, consistent with the design philosophy?". To answer these questions, one must establish the appropriate probability density or distribution functions.

Previous investigations have shown that the probability distribution function for extreme value of structural response for a single earthquake follows closely the Gumbel Type I distribution [1,4]

$$P(\mu) = \exp \{-\exp [-\alpha (\mu - u)]\}$$
(20)

where  $\mu$  is the maximum response measured in terms of ductility factor, and  $\alpha$  and u are parameters which depend on the average and standard deviation of  $\mu$ . If only 20 sample values of  $\mu$  are available as in this investigation,  $\alpha$  and u can be obtained using the relations [11]

$$\alpha = 1.063/\sigma_{11}$$
 (21)

and

$$u = \bar{\mu} - 0.493 \sigma_{u}$$
 (22)

where  $\bar{\mu}$  and  $\sigma_{\mu}$  are the mean and standard deviation of the 20 sample values of  $\mu$ . Using these equations and expressing the standard deviation of  $\mu$  in terms of its coefficient of variation ( $\sigma_{\mu} = c \ \bar{\mu}$ ), Eq. (20) can be written in the nondimensional form

$$P(q) = \exp \left\{-\exp \left[-\frac{1.063}{c} (q - 1 + 0.493c)\right]\right\}$$
(23)

where

$$q \equiv (\mu/\bar{\mu}) \tag{24}$$

This probability distribution function is plotted in Fig. 14 over a range of values of c, i.e. over the range 0 < c < 1.5. Since the probability distribution function is defined such that
$$P(x) \equiv Probability [\mu < x]$$
 (25)

, the probability exceedance function is given by

$$Q(x) \equiv Probability [\mu > x] = 1 - P(x)$$
(26)

The first question previously raised, namely, "What is the probability of these ductility factors being exceeded during a single earthquake of Types A, B, C, D, or B<sub>02</sub>?", can be easily answered using Eq. (26), Fig. 14 and the data provided in Figs. 8a-13d. The second question raised, i.e. "What ductility factors are required consistent with the design philosophy?", is more difficult to answer. Before attempting to answer this question, one must realize that the basic design criteria cannot be met in absolute terms, i.e. with 100% confidence. This complication is due to the scatter of coefficient of variation of ductility factor present for each family of earthquake excitations. The best one can do is reduce the probability of exceedance associated with each of the two ductility factors to an acceptable level. Deciding on an acceptable level is complex as it involves economic, social, and political considerations.

Suppose for example, it was decided that a 15 percent probability of exceedance was acceptable, i.e.  $Q(\mu) = 0.15$  and  $P(\mu) = 0.85$ . Using Fig. 14 and the data provided in Figs. 8a-13d, one can easily establish that ductility factor  $\mu_{85}$  associated with  $P(\mu) = 0.85$ . This has been done for all four trilinear stiffness degrading models subjected to Type A ground motions giving the results shown in Fig. 15.

# 7.2 SELECTION OF REQUIRED STRENGTH LEVELS

To establish the required strength levels of the various structural models for each class of earthquake motions, one must first prescribe basic criteria consistent with the basic design philosophy. In the following discussion, 20, 15, 10 and 5 percent probabilities of exceedance were selected as examples of acceptable risk and it was assumed that moderate and severe earthquake conditions are represented by 0.30g and 0.45g, respectively, for the mean peak acceleration of ground motions. Finally, the two ductility factors, consistent with light and heavy (but controlled) damage, are chosen as 2 and 10 for the origin-oriented shear model and 2 and 4 for the trilinear stiffness degrading model. The values of peak accelerations and ductility factors selected above follow the suggestions of Umemura, et al. [3].

Using data such as shown in Fig. 15 for each structural model and for each type of earthquake motions, i.e. using curves of  $\mu_{85}$  vs.  $T_1$ , one can easily obtain the required strength ratios ( $\beta$  = p/m  $\ddot{\vec{v}}_{_{\rm GO}}$ ) for  $T_1$ ) for a fixed value of  $T_1$  can be used for this evaluation. The resulting required strength ratios for each prescribed risk level can then be plotted as functions of period  $T_1$  as shown in Figs. 16-19 for the trilinear stiffness degrading flexure model subjected to earthquake Types A, B, C and D. Figures 20 and 21 show the required strength ratios corresponding to ductility ratios  $\mu_{80}$ ,  $\mu_{85}$ ,  $\mu_{90}$  and  $\mu_{95}$  equal to 6. Figs. 22 and 23 show similar results but with the ductility ratios equal to 8. These results have no direct relation to the basic design criteria but are of interest in showing the influence of high ductility on the required strength level. One characteristic feature of all sets of curves in these figures is that the four curves representing earthquake Types A, B, C and D are quite close to each other, except for the case of Type D earthquakes when 10 and 5 percent probability of exceedance is prescribed. One finds the required strength ratios are significantly

influenced by the area of the hysteretic loop; see Fig. 6. The required strength ratios for the trilinear model subjected to earthquake Type  $B_{02}$  are shown in Figs. 26 and 27.

One very significant feature to notice in these figures for all five types of earthquakes is that generally, the required strength ratios for the trilinear model in the range  $T_1 > 0.2$  sec. vary in a linear manner with negative slopes along the log scale for  $T_1$ . Converting to a linear scale, the required strength ratios would vary in inverse proportion to the square root of  $T_1$ , i.e.  $\beta \sim (T_1)^{-1/2}$  for  $T_1 > 0.2$  sec. This implies that buildings represented by the trilinear model which have a shorter natural period than the predominant period in the ground motions are likely to suffer excessive deformation, especially in a case of earthquake Type  $B_{02}$ , because a lengthening of the period caused by reduction and degradation of the stiffness brings the characteristic period more in line with the predominant period in the ground motions.

The required strength ratios ( $\beta_s = p_c/m \ \bar{v}_{go}$ ) are shown in Figs. 24 and 25 for the origin-oriented shear model subjected to earthquake Types A, B, C and D. The results in Fig. 24 are obtained for the basic criteria previously established; however, the results in Fig. 25 are for ductility factors  $\mu$  set equal to 1.5 and 5 which represent brittle structures. These latter results show the influence of brittleness on the required strength level. The four curves representing earthquake Type A, B, C and D are quite close to each other similar to the corresponding curves for the trilinear model. The required strength ratios for the shear model subjected to earthquake Type B<sub>02</sub> are shown in Fig. 28. The results in Figs. 24, 25 and especially, in Fig. 28, show a high tendency to peak at T<sub>1</sub> = 0.4 sec. which corresponds with the predominant period of the input ground motions. This tendency is most significant in the case of lower ductility factors which correspond to small degradations in stiffness. The required strength ratios vary in inverse proportion to the square root of  $T_1$  for  $T_1 > 0.4$ . As for the shear model, the period at the peak of these curves becomes smaller with the higher ductility factors which accompany the larger degradations of the stiffness.

When judging which of the two prescribed ductility factors control a particular design or damage assessment, one should be careful not to base the decision on a direct comparison of the required strength ratios as shown in Figs. 16-19, 24, 26 and 28 since these ratios have different normalization factors. For example, consider a shear model with  $T_1 = 0.4$  sec. as shown in Figs. 24c and 24d. Using the light damage criteria, i.e.,  $\ddot{v}_{\alpha\alpha} = 0.30$  g and  $\mu_{85} = 2$ , gives  $\beta = 2.2$  and  $p_c = 0.66$  mg. Using the heavy damage criteria, i.e.  $\vec{v}_{qo} = 0.45$ g and  $\mu_{85} = 10$ , gives  $\beta = 0.8$  and  $p_c = 0.36$  mg. Note that for these two different levels of damage, the resulting values for  $\beta$  have a different ratio to each other than do the two values for  $p_c$ . Obviously in this case, the light damage criteria requiring  $p_c = 0.66$  mg control the design or damage assessment. Let us consider a second example of the origin-oriented model with  $T_1 = 0.15$  sec. In this case the light damage criteria give  $\beta = 1.7$  and  $p_c = 0.51$  mg and the heavy damage criteria give  $\beta = 1.3$  and  $p_c = 0.58$  mg. For this particular structural model, the heavy damage criteria requiring  $p_c = 0.58$  mg control the design or damage assessment. Making similar comparisons for the various trilinear stiffness degrading models represented in Figs. 16-19 and 26, one finds that the heavy damage criteria ( $\ddot{\ddot{v}}_{00} = 0.45$ g and  $\mu_{85} = 4$ ) always control the design or damage assessment.

When using the results in Fig. 16-28 in accordance with the above example calculations, one should remember that they are based on the ground motion parameters  $\omega_0 = 15.6 \text{ rad/sec}$  ( $T_0 = 0.4 \text{ sec}$ ) and  $\xi_0 = 0.6$  which represent firm ground conditions. If one should have quite different ground conditions, these parameters should be adjusted appropriately. These adjustments shift the level of the predominant frequencies in the ground motions and also change the mean intensity level  $\ddot{\ddot{v}}_{go}$ . With considerable experience and using engineering judgment, certain modifications to the data in Figs. 16-28 can be made to reflect these new conditions.

One should also keep in mind that these results do not include the influence of soil-structure interaction which lengthens the natural period and often increases damping in the overall system.

# VIII. CONCLUDING STATEMENT

The response ductility factors and coefficients of variation presented herein provide the necessary data for carrying out probabilistic seismic resistant designs and for conducting damage assessments consistent with basic design criteria and the statistical nature of earthquake ground motions.

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### TABLE 1

Type of	Statistical	Number of Earthquakes			
Earthquake	Quantity	20	40	Infinity	
A	Mean	0.327	0.331	0.332	
	Std. Deviation	0.023	0.036	0.040	
В	Mean	0.300	0.308	0.309	
	Std. Deviation	0.032	0.037	0.041	
С	Mean	0.240	0.243	0.244	
	Std. Deviation	0.022	0.035	0.039	
D	Mean	0.191	0.188	0.189	
	Std. Deviation	0.041	0.039	0.044	
<sup>B</sup> 02	Mean	0.346	0.336	0.337	
	Std. Deviation	0.048	0.049	0.055	

MEAN VALUES AND STANDARD DEVIATIONS OF PEAK GROUND ACCELERATIONS

### TABLE 2

.

STANDARD TIME INTERVAL AND SUBDIVIDED TIME INTERVAL

Interval Type	Natural Period T <sub>1</sub> , sec.					
	0.1 and 0.14	0.2-0.4	0.57-1.13	1.6 and 2.26		
Standard	0.005	0.01	0.01	0.01		
Subdivided	0.000625	0.00125	0.0025	0.005		









FIG. 2 FILTER TRANSFER FUNCTIONS







FIG. 5 TRI-LINEAR HYSTERETIC MODEL





































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FIG. 14 PROBABILITY DISTRIBUTION FUNCTIONS FOR DUCTILITY FACTOR RATIOS ON GUMBEL PLOTS







FIG. 16 REQUIRED STRENGTH RATIOS FOR STRUCTURAL MODELS, DUCTILITY FACTORS, PROBABILITY DISTRIBUTION LEVELS AND EARTHQUAKE TYPES INDICATED



FIG. 17 REQUIRED STRENGTH RATIOS FOR STRUCTURAL MODELS, DUCTILITY FACTORS, PROBABILITY DISTRIBUTION LEVELS AND EARTHQUAKE TYPES INDICATED



FIG. 18 REQUIRED STRENGTH RATIOS FOR STRUCTURAL MODELS, DUCTILITY FACTORS, PROBABILITY DISTRIBUTION LEVELS AND EARTHQUAKE TYPES INDICATED



FIG. 19 REQUIRED STRENGTH RATIOS FOR STRUCTURAL MODELS, DUCTILITY FACTORS, PROBABILITY DISTRIBUTION LEVELS AND EARTHQUAKE TYPES INDICATED





FIG. 20 REQUIRED STRENGTH RATIOS FOR STRUCTURAL MODELS, DUCTILITY FACTORS, PROBABILITY DISTRIBUTION LEVELS AND EARTHQUAKE TYPES INDICATED



FIG. 21 REQUIRED STRENGTH RATIOS FOR STRUCTURAL MODELS, DUCTILITY FACTORS, PROBABILITY DISTRIBUTION LEVELS AND EARTHQUAKE TYPES INDICATED



FIG. 22 REQUIRED STRENGTH RATIOS FOR STRUCTURAL MODELS, DUCTILITY FACTORS, PROBABILITY DISTRIBUTION LEVELS AND EARTHQUAKE TYPES INDICATED



FIG. 23 REQUIRED STRENGTH RATIOS FOR STRUCTURAL MODELS, DUCTILITY FACTORS, PROBABILITY DISTRIBUTION LEVELS AND EARTHQUAKE TYPES INDICATED



FIG. 24 REQUIRED STRENGTH RATIOS FOR STRUCTURAL MODELS, DUCTILITY FACTORS, PROBABILITY DISTRIBUTION LEVELS AND EARTHQUAKE TYPES INDICATED


FIG. 25 REQUIRED STRENGTH RATIOS FOR STRUCTURAL MODELS, DUCTILITY FACTORS, PROBABILITY DISTRIBUTION LEVELS AND EARTHQUAKE TYPES INDICATED



FIG. 26 REQUIRED STRENGTH RATIOS FOR STRUCTURAL MODELS, DUCTILITY FACTORS, PROBABILITY DISTRIBUTION LEVELS AND EARTHQUAKE TYPES INDICATED



FIG. 27 REQUIRED STRENGTH RATIOS FOR STRUCTURAL MODELS, DUCTILITY FACTORS, PROBABILITY DISTRIBUTION LEVELS AND EARTHQUAKE TYPES INDICATED



APPENDIX A

COMPUTER PROGRAM "SHOCHU"

SHCH PROGRAM SHOCHU ( INPUT, OUTPUT, PUNCH ) 1 SHCH 2 SHCH 3 SHCH 4 INPUT DATA SHCH 5 SHCH ð MCONTL INDEX FOR KINDS OF JUB 7 SHCH SHCH 8 MCONTL = 0 STOP SHCH 9 = 1 PSEUDU EARTHQUAKE GENERATION SHCH 1.0 EARTHQUAKE GENERATION AND RESPONSE ANALYSIS OF ≭ 2 SHCH 11 ORIGIN-ORIENTED SHEAR MUDEL SHCH 12 EARTHQUAKE GENERATION AND RESPONSE ANALYSIS OF = .3 SHCH 13 TRI-LINEAR STIFFNESS DEGRADING FLEXURE MGDEL SHCH 14 EARTHQUAKE GENERATION AND RESPONSE ANALYSIS OF SHCH 15 BOTH MODELS SHCH 16 SHCH 17 SHCH 18 SHCH 19 DATA ARE READ IN THE CORRESPONDING SUBROUTINES SHCH 20 ( PSEQGN , ORIGIN , DTRILL ) SHCH 21 SHCH 22 NSTEP = 2 NUMBER OF INTERPOLATION OF ACCELEROGRAM SHCH 23 SHCH 24 SHCH 2,2 SHCH 26 SHCH COMMON AA(32000) 27 COMMON /CNTRL/ NEQREC, T, DT, EAMAX, DAMP, FO, T1, T0, CE2, NOUT(5), HED(8) SHCH 28 1,NEQ,ISHAPE,ACCMAX(40),VELMAX(40),DISMAX(40) SHCH 29 COMMON /GENC/ PI2,NO,NI,NDEC,NTOT,AMPL,01,02,03,04,w0,0,C, SHCH 30 A1, A2, A3, A4, A5, A0, A7, CL, DL, NACC, NVEL SHCH 31 1 SHCH 32 1 READ 100, MCONTL SHCH 35 SHCH 34 IFI MCONTL.EQ.0 ) GO TO 2 SHCH ·· 35 SHCH 36 PSEUDO EARTHQUAKE GENERATION SHCH 37 SHCH 38 CALL PSEQGN SHCH 59 SHCH 40 IF ( MCONTL .EU. 1 ) GO TO 3 SHCH 41 SHCH 42 LINEAR INTERPOLATION OF EARTHQUAKE ACCELERATION SHCH 43 SHCH <u>44</u> NSTEP=2 SHCH 45 SHCH NTOT2=NSTEP+NTOT 46 TH=DT/FLUAT(NSTEP) SHCH 47 CALL ERIKO (AA(NACC), AA(NVEL), NTOT, NSTEP) SHCH 48 SHCH 49 IF ( MCONTL .EQ. 3 ) GO TO 4 SHCH 50 SHCH 51 RESPONSE ANALYSIS OF ORIGIN ORIENTED SHEAR MODEL SHCH 52 SHCH 53 CALL ORIGIN (AA(NVEL), NTOT2, TH, ACCMAX(1)) SHCH 54 SHCH 55 SHCH IF ( MCUNTL .EQ. 2 ) GO TO 3 56 SHCH 57 RESPONSE ANALYSIS OF TRI-LINEAR STIFFNESS DEGRADING FLEXURE MODEL SHCH 58 SHCH 59 4 CALL DTRILI (AA(NVEL), NTUT2, TH, ACCMAX(1)) SHCH 60

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 3 GU TO 1
 SHCH
 61

 2 STOP
 SHCH
 62

 100 FORMAT (15)
 SHCH
 64

 END
 SHCH
 65

C

SUBROUTINE PSEQGN	SHCH	66
	SHCH	- 67
* * * * * * * * * * * * * * * * * * * *	Shch	68
	SHCH	69
PSEUDO EARTHQUAKE GENERATION	SHCH	70
	SHCH	71
PROGRAMMERSP RUIZ AND J PENZIEN,UNIV OF CALIF,BERKELEY. 1969	SHCH	72
NODIFICATIONSNISEE 1972	SHCH	73
MODIFICATIONSM MURAKAMI 1975	SHCH	74
	SHCH	75
* * ☆ ☆ ☆ * * * * ☆ * * * * * * * * * *	SHCH	76
	SHCH	17
COMMUN /CNTRE/ NEOREC.I.DT.EAMAX.DAMP.EO.TI.IJ.CE2.NOUI(6).HED(8)	SHCH	73
$1 \times 10^{-1}$ (Martin Control of the Martin	SHCH	79
COMMON /CENC/ DI2.wo.NI.NOFC.NIDI.AMDI.DI.D2.D3.D4.wo.D.C.	- снен	80
$1 \qquad 1 \qquad 1 \qquad 2 \qquad 1 \qquad 2 \qquad 1 \qquad 2 \qquad 2 \qquad 2 \qquad 1 \qquad 2 \qquad $	снон	a1
	SHCH	37
	311CH	<u>ປະ</u> ບັນ
	SHCH	00
	3000	04
INPUT DATA	SHCH	65
	SHCH	40
NEQREC = NUMBER OF EARTHQUAKE RECORDS	SHCH	87
T = DURATION OF RECORDS	SHCH	88
TH = DT = TIME INCREMENT	SHCH	89
DENST = POWER SPECTRAL DENSITY (CM*+2/SEC++3)	SHCH	90
NOUT=OUTPUT CUNTRUL ARKAY	SHCH	91
	SHCH	92
HIGH FREQUENCY FILTER PARAMETERS	SHCH	83
	SHCH	94
DAMP = DAMPING RATIO	SHCH	95
FO = UNDAMPED NATURAL FREQUENCY (CPS)	SHCH	96
DENST = PUWER SPECTRAL INTENSITY	SHCH	97
	SHCH	98
LOW EREQUENCY ETLIER PARAMETERS	SHCH	99
	SHCH	100
DAMPL = DAMPING RATI()	SHCH	101
EAL = HNDANDED NATINAL ER-OHENCY (CDS)	SHCH	102
THE SUBARED NATIONAL TREADENCY TOTS	SHCH	104
CHADING ENNETTON DADAMETERS	CHEN	104
SHAPING FUNCTION FARABETERS	curu	105
TI - DUDATION OF INITIAL DARAGOLIC SUILDID	SHER	104
TI = DURATION OF INITIAL PARABULIC BOLLOOP	2016-01 2016-01	107
IO = THE AT END OF STATIONART PORTION	ວດພາຍຄ	100
CE2 = EXPONENTIAL DECAY CUNSIANI	SACH	108
ISHAPE = 2 (PARABULIC BUILD-UP PHASE)	SNUM	103
= 3 (CUBIC BUILD-UP)	2HCH	110
	SHCH	LLL
* * * * * * * * * * * * * * * * * * * *	SHCH	115
	SHCH	113
BLANK COMMON STORAGE ALLOCATION	SHCH	114
SET COMMUN AA(NNN) AND NAA=NNN	SHCH	115
	SHCH	116

r	HERE NUN EYCEERS 3#NIGT+NI+NREC	SHCH 117
ç	RHERE NAM EAGEEDS STATUTALTADEC	SHCH 118
5		SHCH 110
<u>د</u>		
۲. ۲		SHCH 121
L C		5000 123 5000 123
ι Γ		SHCH 124
C	* * * * * * * * * * * * * * * * * * * *	SHCH 123
C		5HLH 124
C	NEQREC = I IS REQUIRED FUR RESPONSE ANALYSIS.	SHCH 123
C	IF LAST TWO CARD ARE "BLANK", SUBRUUTINE RETURNS TO MAIN.	SHCH 120
С		SHEH 121
- C -	* * * * * * * * * * * * * * * * * * * *	SHCH 124
C		SHCH 129
	COMMON AA(32000)	SHCH 130
	NAA=32000	SHCH 131
C,		SHCH 132
С	READ SPECIFICATIONS	SHCH 133
C		SHCH 134
·	1 READ 6, HED, NEUREC, T, TH, DENST	SHCH 135
	IF (NEQREC.EQ.0) GO TO 5	SHCH 136
	DT=TH	SHCH 137
	READ 8, DAMP,FO	SHCH 138
	READ 9, ISHAPE	SHCH 139
	READ 3; TI,TO,CE2	SHCH 140
	READ 8, DAMPL, FOL	SHCH 141
	READ 9, NOUT	SHUH 142
	PRINT 10, HED,NEQREC,DENS[,T,DT,NGUT,FD,DAMP,FJL,DAMPL,[],ISHAPE,	SHCH 143
	1T0,CE2	SHCH 144
C		SHCH 145
	NTUT=T/DT+1.0001	SHCH 146
	NO=T0/DT+1.0001	SHCH 147
	NI=TI/DT+1.0001	SHCH 148
	NDEC=NTDT-NO+1	SHCH 149
	MAA=3*NTOT+NDEC+NI+1	SHCH 150
	IF (NAA-MAA) 2,3,3	SHCH 151
	2 PRINT 7, MAA	SHCH 152
	STOP	SHCH 153
	3 CONTINUE	SHCH 154
С		SHCH 155
С	STORAGE ALLOCATION	SHCH 156
C		SHCH 157
	NP = 1	SHCH 158
	NP1≖NP+NDEC	SHCH 159
	NACC=NP1+N1	Sheh 160
	NVEL=NACC+NTUT	SHCH 161
	NDI SP=NVEL+NTUT	SHCH LO2
C		SHCH 103
С	GENERATE INTENSITY-TIME FUNCTION	SHCH 164
С		SHCH 165
	CALL SHAPE (AA(NP),AA(NP1),NI,NDEC)	SHCH 106
C		SHCH 167
Ċ	GENERAL CONSTANTS	SHCH 168
Ċ		SHCH 109
	PI2=6.2831853	SHCH 170
	¥0=PI2*F0	SHCH 171
	D=2.+DAMP+wO	SHCH -172
	A2=6./DT	SHCH 173
		CUCU 174
	Al=A2/DT	- 2000 TIA
÷	A1=A2/DT A3=3./DT	SHCH 175

.

A7=A4       SHCH 17         A5=A7POT/3-Q       ShCH 17         C=A10PA3+HOMO       ShCH 17         GL=22+0AMPL+A0L       ShCH 17         DL=22+0AMPL+A0L       ShCH 16         AMPL=SQRT(AMPL)       ShCH 16         DL=22+0AMPL+A0L       ShCH 16         AMPL=SQRT(AMPL)       ShCH 16         DL=22+0AMPL+A0L       ShCH 16         AMPL=SQRT(AMPL)       ShCH 16         D1=01/T       ShCH 16         D2=0101/T       ShCH 16         D3=02001       ShCH 16         D4=03901       ShCH 16         GENERATE,PRINT AND PUNCH RECORDS       ShCH 19         D0 4 NEQ=1,NEQREC       ShCH 19         CALL GEN (AA(NPL),AA(NACC),AA(NUEL),AA(NUESP))       ShCH 19         CALL GEN (AA(NPL),AA(NACC),AA(NUEL),AA(NUISP))       ShCH 19         CONTINUE       RETURN       ShCH 19         FORMAT (///2LH EXECUTION TERMINATED/       ShCH 20         ShCH 10 <th></th> <th></th> <th></th> <th>••••••••••••••••••••••••••••••••••••••</th> <th></th>				••••••••••••••••••••••••••••••••••••••	
A7=A4       SHCH 17         A5=A7*0773.Q       SHCH 17         A5=2.0*A5       SHCH 17         C=A1*0*A3+00*A0       SHCH 17         DU.=P12*F0L       SHCH 18         DL=2.*DAMPL*A0L       SHCH 18         CL=A1*01*A3+00*00       SHCH 18         MU.=P12*DENST/01       SHCH 18         AMPL=SQRT(AMPL)       SHCH 18         D1=0171       SHCH 17         D2=010171       SHCH 18         D3=02*01       SHCH 18         D4=03*01       SHCH 19         GENERATE,PRINT AND PUNCH RECURDS       SHCH 19         D0 4 NE0=1.NEQAEC       SHCH 19         CALL QEN (AA(NPL),AA(NACC),AA(NVEL),AA(NDISP))       SHCH 19         CONTINUE       SHCH 19         GONTINUE       SHCH 19         FORMAT (Y/2LH EXECUTION TERMINATED/       SHCH 19         SHCH 17       SHCH 19         SHCH 18       SHCH 19         SHCH 19       SHCH 19         SHCH 10       SHCH 19         SHCH 10       SHCH 19         SHCH 19       SHCH 19         SHCH 19       SHCH 19         SHCH 10       SHCH 19         SHCH 10       SHCH 19         SHCH 10       SHCH 19			•		
A7-A4       SHCH 17         A5-A76707/3-Q       SHCH 18         WQL=P12#F0L       SHCH 18         QL=2.567874E+00L       SHCH 18         CL=31014312       SHCH 17         SHCH 17       SHCH 18         AMPL-F120ENST/01       SHCH 18         SHCH 17       SHCH 18         D3-02701       SHCH 18         SHCH 201501       SHCH 18         SHCH 17       SHCH 17         SHCH 17       SHCH 17         SHCH 17       SHCH 18         SHCH 17       SHCH 18         SHCH 18       SHCH 18         SHCH 18       SHCH 18         SHCH 19       SHCH 19         SHCH 19       SHCH 18			4 P		
AS=A7*01/3.0       SHCH 17         C=A1+0*A3+H0*A0       SHCH 18         VDL=P12*P01       SHCH 18         DL=2.*0AMPL*N01       SHCH 18         SHCH 19       SHCH 18         DL=2.*0AMPL*N01       SHCH 18         SHCH 19       SHCH 18         SHCH 19       SHCH 18         SHCH 17       SHCH 18         SHCH 18       SHCH 18         SHCH 17       SHCH 18         SHCH 18       SHCH 18         SHCH 19       SHCH 18         SHCH 17       SHCH 18         SHCH 17       SHCH 18         SHCH 18       SHCH 18         SHCH 19       SHCH 18         SHCH 19       SHCH 18         SHCH 19       SHCH 19         SHCH 10       SHCH 20 </td <td>A7=A4</td> <td></td> <td>SHC</td> <td>CHI -</td> <td>17</td>	A7=A4		SHC	CHI -	17
AG-2.0.045       SHCH 17         C-AL+00#A+HO*RO       SHCH 18         DL-2.00APL+#0L       SHCH 18         DL-2.00APL+#0L       SHCH 18         DL-2.00APL+#0L       SHCH 18         AMPL-SQRTLAMPL,       SHCH 18         AMPL-SQRTLAMPL,       SHCH 18         D1-DI/T       SHCH 18         D2-010/T       SHCH 18         D3-02401       SHCH 18         GENERATE, PRINT AND PUNCH RECORDS       SHCH 18         GENERATE, PRINT AND PUNCH RECORDS       SHCH 19         GCALL GEN (AA(NP), AA(NPL), AA(NACC), AA(NVEL), AA(NÚISP))       SHCH 19         CALL GEN (AA(NP), AA(NPL), AA(NACC), AA(NVEL), AA(NÚISP))       SHCH 19         CONTINUE       SHCH 19       SHCH 19         CONTINUE       SHCH 10       SHCH 10         GO TO 1       SHCH 10       SHCH 10         FORMAT (#A4/15, 3F10,0)       SHCH 10       SHCH 20         FORMAT (#A4/15, 3F10,0)       SHCH 20       SHCH 20         FORMAT (#A4/15, 3F10,0)       SHCH 20       SHCH 20         FORMAT (#A4/	A5=A7+D	T/3.Q	SHC	ิท	17
$ \begin{array}{llllllllllllllllllllllllllllllllllll$	A6=2.0+	A5	SHC	Сн	17
W0L=P1[2+F0L         ShCH 18           Cl=2.ex0APRL=40L         ShCH 18           Cl=2.ex0APRL=40L         ShCH 18           Cl=2.ex0APRL=40L         ShCH 18           Cl=2.ex0APRL=40L         ShCH 18           AMPL=F2EPENST/DI         ShCH 18           AMPL=F2EPENST/DI         ShCH 18           AMPL=F2EPENST/DI         ShCH 18           D1=01/T         ShCH 18           D2=010/T         ShCH 18           D3=02201         ShCH 18           GENERATE,PRINT AND PUNCH RECURDS         ShCH 19           CALL GEN (AA(NP);AA(NPL);AA(NACC);AA(NVEL);AA(NÙISP))         ShCH 19           CALL GEN (AA(NP);AA(NPL);AA(NACC);AA(NVEL);AA(NÙISP))         ShCH 19           GONTINUE         ShCH 19           CONTINUE         ShCH 19           GONTINUE         ShCH 19           FORMAT (1//2LH EXECUTION TERMINATED/         ShCH 20           I         27H + ****SE USER GUIDE TO SET /         ShCH 20           J         ShCH 19         ShCH 20           FORMAT (1//2LH EXECUTION TERMINATED/         ShCH 20           J         ShCH 20         ShCH 20           J         ShCH 20         ShCH 20           J         ShCH 20         ShCH 20 <td< td=""><td>C=A1+D*</td><td>A3+W0*W0</td><td>SHC</td><td>Сн</td><td>18</td></td<>	C=A1+D*	A3+W0*W0	SHC	Сн	18
$\begin{aligned} D_{1-2} + 0 D AP D_{1-2} D D_{1-2} + 0 D & SiGH 18 \\ SiGH 18 + 0 D_{1-2} P D D SiGH + 0 D & SiGH 18 \\ SiGH 18 + 0 D_{1-2} P D D SiGH + 0 D & SiGH 18 \\ SiGH 18 + 0 D_{1-2} D D SiGH + 0 D & SiGH 18 \\ D D_{1-2} D D D & SiGH 18 & SiGH 18 \\ D D_{1-2} D D D & SiGH 18 & SiGH 18 \\ D D_{1-2} D D D & SiGH 18 & SiGH 18 \\ D D D & SiGH 19 \\ CALL GOT (AA(NPL)_{AA(NPL)_{AA(NCC)_{AA(NVL)_{AA(NUSP)_{1-2}}}} & SiGH 19 \\ SiGH 19 \\ G D (1 C AA(NACC)_{AA(NVL)_{AA(NDL)_{AA(NDSP)_{1-2}}} & SiGH 19 \\ SiGH 19 \\ G D T D & SiGH 19 \\ G D T D & SiGH 19 \\ SiGH 19 \\ G D T D & SiGH 19 \\ SiGH 19 \\ G D T D & SiGH 19 \\ SiGH 10 \\ SiGH 10 \\ SiGH 10 \\ SiGH 20 \\ SiGH 10 \\ SiGH 10 \\ SiGH 20 \\ SiGH 10 \\ SiGH 10 \\ SiGH 10 \\ SiGH 10 \\ SiGH 20 \\ SiGH 10 \\ SiGH 20 \\ SiGH 10 \\ SiGH 10 \\ SiGH 10 \\ SiGH 20 \\ $	WOL=PI2	*FOL	SHC	CH -	18
$ \begin{array}{llllllllllllllllllllllllllllllllllll$	0L=2.*D	AMPL+WOL	SHC	СH	18
$ \begin{array}{llllllllllllllllllllllllllllllllllll$	CL=A1+D	L*A3+#0L*#0L	SHC	CH	18
AMPL-SQRT(AMPL)       SHCH 18         D1=OT/T       SHCH 18         D2=D1+D1/T       SHCH 18         D3=D2+D1       SHCH 18         D4=D3*D1       SHCH 18         GENERATE,PRINT AND PUNCH RECORDS       SHCH 18         D0 4 NEQ=1,NEDREC       SHCH 19         CALL GEN (AA(NP),AA(NACC),AA(NVEL),AA(NDISP))       SHCH 19         CALL GEN (AA(NP),AA(NACC),AA(NVEL),AA(NDISP))       SHCH 19         CONTINUE       SHCH 19         CONTINUE       SHCH 19         CONTINUE       SHCH 19         FORMAT (BA4/I5, JF10.0)       SHCH 19         FORMAT (BA4/I5, JF10.0)       SHCH 20         FORMAT (BA4/I SA AND DIMENSIUM DF ARRAY AA )       SHCH 20         FORMAT (BL0.4)       SHCH 20         J2       J3H NAA AND DIMENSIUM DF	AMPL=PI	2+DENST/DT	SHC	Сн	18
D1-DT/T       SHCH 18         D2-D1+D1/T       SHCH 18         D3-D2*D1       SHCH 18         D4-D3*D1       SHCH 18         GENERATE,PRINT AND PUNCH RECORDS       SHCH 18         D0 4 NEQ=1,NEQREC       SHCH 19         CALL GEN (AA(NP),AA(NPL),AA(NACC),AA(NVEL),AA(NDISP))       SHCH 19         CALL GUT (AA(NACC),AA(NVEL),AA(NDISP),NFDT)       SHCH 19         CALL GUT (AA(NACC),AA(NVEL),AA(NDISP),NFDT)       SHCH 19         CONTINUE       SHCH 19         CONTINUE       SHCH 19         RETURN       SHCH 19         FORMAT (BA4/15,3F10.0)       SHCH 20         FORMAT (BA4/15,3F10.0)       SHCH 20         FORMAT (BA4/15,3F10.0)       SHCH 20         FORMAT (BA4/15,3F10.0)       SHCH 20         FORMAT (BF10.4)       SHCH 20         SHCH 20       SHCH 20         SHCH 20       SHCH 20         J       27HSEE USER GUIDE TO SET /         Z       35H       NAA AND DIMENSIUN OF ARRAY AA )         FORMAT (BF10.4)       SHCH 20         J       32H DURATION OF RECORDS = ,15/         J       32H NUMBER OF EARTHQUAKE RECORDS = ,15/         J       32H NUMBER OF EARTHQUAKE RECORDS = ,15/         SHCH 20       SHCH 2	AMPL≠SQ	RT(AMPL)	SHC	H	18
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	01=0T/T		SHO	Сн	18
$\begin{array}{llllllllllllllllllllllllllllllllllll$	D2=01*D	1/T	SHC	CH	18
$\begin{array}{llllllllllllllllllllllllllllllllllll$	D3=02*D	1	SHC	СН	18
GENERATE,PRINT AND PUNCH RECURDSSHCH 19DU 4 NEQ=1,NEQRECSHCH 19CALL GEN (AA(NP),AA(NPL),AA(NOISP),NFOT)SHCH 19CALL GUT (AA(NACC),AA(NVEL),AA(NOISP),NFOT)SHCH 19CALL OUT (AA(NACC),AA(NVEL),AA(NOISP),NFOT)SHCH 19CONTINUESHCH 19GO TO 1SHCH 19CONTINUESHCH 19RETURNSHCH 19FORMAT (BA4/15, 3F10.0)SHCH 19FORMAT (BA4/15, 3F10.0)SHCH 20FORMAT (BA4/16, 10)SHCH 20SHCH 20SHCH 20SHCH 20SHCH 20235H NAA AND DIMENSION OF ARRAY AA )FORMAT (GH10.4)SHCH 20FORMAT (GH10.4)SHCH 20FORMAT (GH10.4)SHCH 20FORMAT (GH10.4)SHCH 20SHCH 20SHCH 20SHCH 21SHCH 2032H NUMBER OF EARTHQUAKE RECORDS = ,15/32H NUMBER OF EARTHQUAKE RECORDS = ,15/32H NUMBER OF EARTHQUAKE RECORDS = ,15/32H NUAAL FREQUENCY = ,10.5/32H DURATION OF RECORDS (SECS) = , FL0.5/33H LOA FREQUENCY = ,FL0.5/34H DURATION OF RECORDS (SECS) = , FL0.5/34H DURATION OF RECORT = ,FL0.5////34H DURATION OF RECORT = ,FL0.5////<	D4=D3*D	1	SHC	CH	18
GENERATE, PRINT AND PUNCH RECURDSSHCH 19D0 4 NEQ=1, NEQAECSHCH 19CALL GEN (AA(NP1), AA(NACC), AA(NVEL), AA(NDISP))SHCH 19CALL OUT (AA(NACC), AA(NVEL), AA(NDISP), NTDT)SHCH 19CONTINUESHCH 19GO TO 1SHCH 19CONTINUESHCH 19CONTINUESHCH 19CONTINUESHCH 19CONTINUESHCH 19CONTINUESHCH 10RETURNSHCH 20FORMAT (#A4/15, 3F10.0)SHCH 20FORMAT (#A1000 F EXERUPTION OF ARRAY AA )SHCH 20SHCH 20SHCH 20235H NAA AND DIMENSIUN OF ARRAY AA )FORMAT (BF10.4)SHCH 20FORMAT (1000 F EARTHQUAKE RECORDS = ,15/SHCH 20SHCH 20232H INTENSITY (CM**2/SEC**3) = ,F10.5/SHCH 21332H DURDUT CUN ROL ARRAY = ,611////SHCH 21332H DURPUT CUN ROL ARRAY = ,611////SHCH 21333H HIGH FREQUENCY FILTER PROPERTIES //SHCH 22333H LOM FREQUENCY FILTER PROPERTIES //333H LOM FREQUENCY FILTER PROPERTIES //333H LOM FREQUENCY FILTER PROPERTIES //332H DUAAL FREQUENCY FILTER PROPERTIES //332H DUAAL FREQUENCY FILTER PROPERTIES //			SHC	CH	19
D0 4 NEQ=1,NEQRECSHCH 19CALL GEN (AA(NP1),AA(NACC),AA(NVEL),AA(NDISP))SHCH 19CALL OUT (AA(NACC),AA(NVEL),AA(NDISP),NTDT)SHCH 19CONTINUESHCH 19GO TO 1SHCH 19GO TO 1SHCH 19CONTINUESHCH 19RETURNSHCH 19FORMAT (BA4/15, JF10.0)SHCH 10FORMAT (BA4/15, JF10.0)SHCH 20FORMAT (BA4/15, JF10.0)SHCH 20FORMAT (CHAPE SEE GUIDE TO SET /SHCH 20235HNAA AND DIMENSIUN OF ARRAY AA )FORMAT (GF10.4)SHCH 20FORMAT (GF10.4)SHCH 20FORMAT (GF10.4)SHCH 20FORMAT (GF10.4)SHCH 20SHC 100 DE EARTHQUAKE RECORDS = ,15/SHCH 20132H NUMBER OF EARTHQUAKE RECORDS = ,160.5/132H NUMBER OF EARTHQUAKE RECORDS = ,160.5/232H DURATION OF RECORDS (SECS) = ,F10.5/32H DURATION OF RECORDS (SECS) = ,F10.5/32H DURATION OF RECORDS (SECS) = ,F10.5/32H DURATION OF ARRAY P = ,611////532H DURATION OF REQUENCY FILTER PROPERTIES //33H LOA FREQUENCY FILTER	GENERAT	E, PRINT AND PUNCH RECORDS	SHC	СН	19
D0 4 NEGAI,NEGAEC       SHCH 19         CALL GEN (AA(NP),AA(NPI),AA(NACC),AA(NVEL),AA(NDISP))       SHCH 19         CALL OUT (AA(NACC),AA(NVEL),AA(NDISP),NIGT)       SHCH 19         CUNTINUE       SHCH 19         GO TO 1       SHCH 19         CONTINUE       SHCH 19         RETURN       SHCH 19         PORMAT (BA4/15,3F10.0)       SHCH 20         FORMAT (A4/15,3F10.0)       SHCH 20         FORMAT (BA4/15,3F10.0)       SHCH 20         FORMAT (BA4/16,10)       SHCH 20         SHCH 20			SHC	СН	19
CALL GEN (AA(NPI), AA(NACC), AA(NUALC), AA(NULSP))SHCH 19CALL GUT (AA(NACC), AA(NUCL), AA(NULSP), NTOT)SHCH 19CONTINUESHCH 19GO TO 1SHCH 19RETURNSHCH 19RETURNSHCH 10FORMAT (7/721H EXECUTION TERMINATED/SHCH 20FORMAT (7/721H EXECUTION TERMINATED/SHCH 20127HSEE USER GUIDE TO SET /SHCH 20235HNAA AND DIMENSIUN OF ARRAY AA )SHCH 20FORMAT (8F10.4)SHCH 20SHCH 20FORMAT (8F10.4)SHCH 20SHCH 20FORMAT (611)SHCH 20SHCH 20FORMAT (611)SHCH 20132H NUMBER OF EARTHQUAKE RECORDS = ,15/SHCH 20232H INTENSITY (CM**2/SEC**3) = ,F10.5/SHCH 20332H DURATION OF RECORDS (SECS) = ,F10.5/SHCH 21332H DURATION OF RECORDS (SECS) = ,F10.5/SHCH 21432H TIME INCREMENT (SECS) = ,F10.5/SHCH 21532H OUTPUT GUNTROL ARRAY = ,511/1//SHCH 21633H HIGH FREQUENCY FILTER PROPERTIES //SHCH 21720H DAATURAL FREQUENCY F.F10.5/SHCH 21820H DAATURAL FREQUENCY F.F10.5/SHCH 22933H LOW FREQUENCY F.F10.5///SHCH 22132H BURDING OF BULDONU = ,F10.5///SHCH 2232H BURDING GUTON DARAMETERS //SHCH 2232H BURDING OF BULDONU = ,F10.5////SHCH 2232H BURDING OF BULDONU = ,F10.5////SHCH 2232H BURDING OF BULDONU = ,F10.5////SHCH 2232H BURDING OF B	DU 4 NE	Q=1,NEQREC	SHC	ΞH	19
CALL DUT (AA(NALC), AA(NVEL), AA(NDISP), NTUT)       SHCH 19         GO TO 1       SHCH 19         GO TO 1       SHCH 19         CONTINUE       SHCH 19         RETURN       SHCH 19         FDRMAT (BA4/15, 3F10.0)       SHCH 20         FORMAT (///21H EXECUTION TERMINATED/       SHCH 20         J1       27H	CALL GE	N (AA(NP), AA(NP1), AA(NACC), AA(NVEL), AA(NDISP))	SHC	h	19
CONTINUE       SHCH 19         GO TO 1       SHCH 19         CONTINUE       SHCH 19         RETURN       SHCH 19         RETURN       SHCH 19         FORMAT (844/15, 3F10.0)       SHCH 20         FORMAT (7//21H EXECUTION TERMINATED/       SHCH 20         1       27HSEE USER GUIDE TO SET /       SHCH 20         2       35H       NAA AND DIMENSION OF ARRAY AA )       SHCH 20         FORMAT (8F10.4)       SHCH 20       SHCH 20         FORMAT (611)       SHCH 20       SHCH 20         FORMAT (111,864//       SHCH 20       SHCH 20         1       32H NUMBER OF EARTHQUAKE RECORDS = ,15/       SHCH 20         1       32H NUMBER OF EARTHQUAKE RECORDS = ,15/       SHCH 20         1       32H NUMBER OF EARTHQUAKE RECORDS = ,15/       SHCH 20         2       32H INTENSITY (CM**2/SEC**3) = ,F10.5/       SHCH 21         3       32H DURATION OF RECORDS (SECS) = ,F10.5/       SHCH 21         3       32H DURATION OF RECORDS (SECS) = ,F10.5/       SHCH 21         3       32H DURAFREQUENCY FILTER PROPERTIES //       SHCH 21         5       32H OUPPING RATIO = ,F10.5////       SHCH 21         8       20H DAMPING RATIO = ,F10.5////       SHCH 21	CALL OU	T (AA(NACC),AA(NVEL),AA(NDISP),NIDI)	SHU	H	19
GU 10 1       SHCH 19         RETURN       SHCH 19         RETURN       SHCH 19         PORMAT (BA4/15, 3F10.0)       SHCH 20         FORMAT (1//21H EXECUTION TERMINATED/       SHCH 20         1       27HSEE USER GUIDE TO SET /       SHCH 20         2       35H       NAA AND DIMENSION OF ARRAY AA )       SHCH 20         FORMAT (611)       SHCH 20       SHCH 20         SHCH 21       SHCH 20       SHCH 20         SHCH 20       SHCH 20       SHCH	CONTINU	E · · · · ·	SHU	H	19
CUNTINGE       Shch 19         RETURN       Shch 20         FORMAT (///21H EXECUTION TERMINATED/       Shch 20         FORMAT (///21H EXECUTION TERMINATED/       Shch 20         1       27HSEE USER GUIDE TO SET /       Shch 20         2       35H       NAA AND DIMENSION OF ARRAY AA )       Shch 20         1       27HSEE USER GUIDE TO SET /       Shch 20         2       35H       NAA AND DIMENSION OF ARRAY AA )       Shch 20         1       DERMAT (8F10.4)       Shch 20       Shch 20         FORMAT (8F10.4)       Shch 20       Shch 20       Shch 20         1       32H NUMBER OF EARTHQUAKE RECORDS = ,15/       Shch 20         2       32H INTENSITY (CM**2/SEC**3) = ,F10.5/       Shch 20         3       32H DURATION OF RECORDS (SECS) = ,F10.5/       Shch 21         3       32H DURATION OF RECORDS (SECS) = ,F10.5/       Shch 21         5       32H DUTPUT CONTROL ARRAY = ,611////       Shch 21         5       32H DURATION OF REQUENCY =,F10.5/       Shch 21         7       20H DAMPING RATIO = ,F10.5////       Shch 21         8       20H DAMPING RATIO = ,F10.5////       Shch 21         9       33H LOA FREQUENCY =,LTER PRUPERTIES //       Shch 21         9 <td>GO IO L</td> <td>-</td> <td>Srit</td> <td>-H</td> <td>19</td>	GO IO L	-	Srit	-H	19
RETURN       SACH 13         FORMAT (BA4/15, JF10.0)       SHCH 20         FORMAT (///21H EXECUTION TERMINATED/       SHCH 20         1       27HSEE USER GUIDE TO SET /       SHCH 20         2       35H NAA AND DIMENSION OF ARRAY AA )       SHCH 20         FORMAT (BF10.4)       SHCH 20         SHCH 20       SH	CUNTINU	E	SHU	- <b>n</b>	12
FORMAT (8A4/15, 3FL0.0)ShCH 20FORMAT (///21H EXECUTION TERMINATED/ShCH 20127HSEE USER GUIDE TO SET /ShCH 20235H NAA AND DIMENSION OF ARRAY AA )ShCH 20FORMAT (8F10.4)ShCH 20FORMAT (611)ShCH 20FORMAT (611)ShCH 20FORMAT (111, 8A4//ShCH 20132H NUMBER OF EARTHQUAKE RECORDS = ,15/ShCH 20232H NUMBER OF EARTHQUAKE RECORDS = ,15/ShCH 2032H DURATION OF RECORDS (SECS) = ,F10.5/ShCH 20332H DURATION OF RECORDS (SECS) = ,F10.5/ShCH 21332H DURATION OF RECORDS (SECS) = ,F10.5/ShCH 21633H HIGH FREQUENCY FILTER PROPERTIES //ShCH 21720H DAMPING RATIO = ,F10.5////ShCH 21820H DAMPING RATIO = ,F10.5////ShCH 21933H LOW FREQUENCY FILTER PROPERTIES //ShCH 21933H LOW FREQUENCY =,F10.5////ShCH 21933H LOW FREQUENCY =,F10.5////ShCH 2210DAMPING RATIO = ,F10.5////ShCH 221128H SHAPING FUNCTION PARAMETERS //ShCH 2212ShCH 22ShCH 221332H DURATION OF BUID-UP=,F10.5////14SHCH 20 ShCH 2ShCH 221532H DURATION OF BUID-UP=,F10.5////1633H HIGH FREQUENCY =,F10.5////ShCH 221720H DURATION OF BUID-UP=,F10.5////1820H DURATION OF BUID-UP=,F10.5////1932H DURATIAL DECAY CUNSTANT = ,F10.5////ShCH	REIUKN		· 5-Fi	- <b>H</b>	23
FORMAT (BA4/15, 3F10.0)       SHCH 20         FORMAT (///21H EXECUTION TERMINATED/       SHCH 20         i       27HSEE USER GUIDE TO SET /       SHCH 20         i       27HSEE USER GUIDE TO SET /       SHCH 20         i       27HSEE USER GUIDE TO SET /       SHCH 20         i       27HSEE USER GUIDE TO SET /       SHCH 20         i       35H       NAA AND DIMENSION OF ARRAY AA )       SHCH 20         FORMAT (6F1)       SHCH 20       SHCH 20       SHCH 20         i       35H       NAA AND DIMENSION OF ARRAY AA )       SHCH 20         FORMAT (6F1)       SHCH 20       SHCH 20       SHCH 20         i       32H NUMBER OF EARTHQUAKE RECORDS = ,15/       SHCH 20       SHCH 20         i       32H NUMBER OF EARTHQUAKE RECORDS = ,15/       SHCH 20       SHCH 20         i       32H NUMBER OF RECORDS (SECS) = ,F10.5/       SHCH 20       SHCH 20         i       32H DURATION OF RECORDS (SECS) = ,F10.5/       SHCH 21       SHCH 20         i       32H OUTPUT CONTROL ARRAY = ,611////       SHCH 21       SHCH 21         i       32H OUTPUT CONTROL ARRAY = ,611////       SHCH 21       SHCH 21         i       32H OUTPUT CONTROL ARRAY = ,610.5////       SHCH 21       SHCH 21			SHU	<b>сп</b>	20
FORMAT(ba/r), br (ba)Shch 20i27HSEE USER GUIDE TO SET /Shch 20i27HSEE USER GUIDE TO SET /Shch 20i35HNAA AND DIMENSIUN OF ARRAY AA )Shch 20iFORMAT (8F10.4)Shch 20iFORMAT (611)Shch 20i32HNUMBER OF EARTHQUAKE RECORDS = ,15/Shch 20i32HNUMBER OF EARTHQUAKE RECORDS = ,15/Shch 20i32HNUMBER OF EARTHQUAKE RECORDS = ,16/Shch 20i32HNUMBER OF EARTHQUAKE RECORDS = ,15/Shch 20i32HNUMBER OF EARTHQUAKE RECORDS = ,16/Shch 21i32HNUMATION OF RECORDS (SECS) = ,F10.5/Shch 21i32HNUTROL ARRAY = ,610.5////Shch 22i32HNUTROL ARRAY = ,610.5////Shch 22i32HNUTROL ARRAY = ,610.5////Shch 22i32HNUTROL ARRAY = ,610.5/	FORMAT		Since	רו⊷ רו∼	20
PORMAT (7/21H EXECUTION TENTINATED)       SHCH 20         2       35H       NAA AND DIMENSIUN OF ARRAY AA )       SHCH 20         2       35H       NAA AND DIMENSIUN OF ARRAY AA )       SHCH 20         2       35H       NAA AND DIMENSIUN OF ARRAY AA )       SHCH 20         2       35H       NAA AND DIMENSIUN OF ARRAY AA )       SHCH 20         5       0 FORMAT (611)       SHCH 20       SHCH 20         1       32H NUMBER OF EARTHQUAKE RECORDS = ,15/       SHCH 20         2       32H INTENSITY (CM**2/SEC**3)       = ,F10.5/       SHCH 20         3       32H DURATION OF RECORDS (SECS)       = ,F10.5/       SHCH 21         3       32H DURATION OF RECORDS (SECS)       = ,F10.5/       SHCH 21         4       32H TIME INCREMENT (SECS)       = ,F10.5/       SHCH 21         5       32H OUTPUT CONTROL ARRAY       = ,610.7///       SHCH 21         6       33H HIGH FREQUENCY =,F10.5/       SHCH 21       SHCH 21         7       20H NATURAL FREQUENCY =,F10.5/       SHCH 21       SHCH 21         8       20H DAMPING RATIO       = ,F10.5////       SHCH 21         9       33H LOW FREQUENCY =,F10.5/       SHCH 21         14       20H DAMPING RATIO       =,F10.5////       SHCH	EDDWAT	(///DILL EVECATION TEDMINATED/	30C SHC	сп ^ ц	20
1       27       35H       NAA AND DIMENSIUN OF ARRAY AA )       SHCH 20         2       35H       NAA AND DIMENSIUN OF ARRAY AA )       SHCH 20         2       1       35H       NAA AND DIMENSIUN OF ARRAY AA )       SHCH 20         2       1       35H       NAA AND DIMENSIUN OF ARRAY AA )       SHCH 20         2       1       32H       NUMBER OF EARTHQUAKE RECORDS = ,15/       SHCH 20         2       32H       INTENSITY (CM**2/SEC**3)       = ,610.5/       SHCH 20         2       32H       INTENSITY (CM**2/SEC**3)       = ,610.5/       SHCH 20         2       32H       INTENSITY (CM**2/SEC**3)       = ,610.5/       SHCH 20         3       32H DURATION OF RECORDS (SECS)       = ,610.5/       SHCH 21         3       32H DURATION OF RECORDS (SECS)       = ,610.5/       SHCH 21         3       32H DURATION OF RECORDS (SECS)       = ,610.5/       SHCH 21         3       32H DURATION OF RECORDS (SECS)       = ,610.5/       SHCH 21         3       32H DURATION OF RECORDS (SECS)       = ,610.5/       SHCH 21         4       32H DURATION AGR RATIO       = ,610.5////       SHCH 21         5       32H NDW AGRATIO       = ,610.5////       SHCH 21	FURMAT	376 CEE NCED (NUDE TO CET /		сп °ы	20
2Since and of the North State of Arken and a second se	1	25H - NAA ANDZDIMENSION DE APPAY AA N	SHO	сн Сн	20
FORMAT (611)SHCH 20FORMAT(1H1,8A4//SHCH 20132H NUMBER OF EARTHQUAKE RECORDS = ,15/SHCH 20232H INTENSITY (CM**2/SEC**3) = ,F10.5/SHCH 20332H DURATION OF RECORDS (SECS) = ,F10.5/SHCH 21432H TIME INCREMENT (SECS) = ,F10.5/SHCH 21532H DUTPUT CONTROL ARRAY = ,611////SHCH 21633H HIGH FREQUENCY FILTER PROPERTIES //SHCH 21720H NATURAL FREQUENCY FILTER PROPERTIES //SHCH 21820H DAMPING RATIO = ,F10.5////SHCH 21933H LOW FREQUENCY FILTER PROPERTIES //SHCH 21933H LOW FREQUENCY FILTER PROPERTIES //SHCH 2120H NATURAL FREQUENCY =,F10.5/SHCH 21532H DURATION OF BUILD-UP= ,F10.5////532H DURATION OF BUILD-UP= ,F10.5////532H DURATION OF BUILD-UP= ,F10.5///832H DURATION OF BUILD-UP= ,F10.5///932H SHAPING FUNCTION PARAMETERS //SHCH 22932H DURATION OF BUILD-UP= ,F10.5///532H DURATION OF BUILD-UP= ,F10.5///532H DURATION OF BUILD-UP= ,F10.5///532H TIME AT BEGINNING OF DECAY= ,F10.5////532H TIME AT BEGINNING OF DECAY= ,F10.5////632H EXPONENTIAL DECAY CONSTANT= ,F10.5////7SHCH 22SHCH 228SHCH 22932H EXPONENTIAL DECAY CONSTANT= ,F10.5////932H EXPONENTIAL DECAY CONSTANT= ,F10.5//// <td>ENDMAT</td> <td></td> <td>SHC</td> <td>°н</td> <td>20</td>	ENDMAT		SHC	°н	20
FORMAT(1H1,844//       SHCH 20         1       32H NUMBER OF EARTHQUAKE RECORDS = ,15/       SHCH 20         2       32H INTENSITY (CM**2/SEC**3) = ,F10.5/       SHCH 21         3       32H DURATION OF RECORDS (SECS) = ,F10.5/       SHCH 21         3       32H DURATION OF RECORDS (SECS) = ,F10.5/       SHCH 21         4       32H TIME INCREMENT (SECS) = ,F10.5/       SHCH 21         5       32H OUTPUT CONTROL ARRAY = ,611////       SHCH 21         6       33H HIGH FREQUENCY FILTER PROPERTIES //       SHCH 21         7       20H NATURAL FREQUENCY =,F10.5/       SHCH 21         8       20H DAMPING RATIO = ,F10.5////       SHCH 21         9       33H LOW FREQUENCY =,F10.5/       SHCH 21         9       33H LOW FREQUENCY =,F10.5/       SHCH 21         9       33H LOW FREQUENCY =,F10.5/       SHCH 21         10       DAMPING RATIO = ,F10.5////       SHCH 21         11       SOM NATURAL FREQUENCY =,F10.5/       SHCH 21         11       SOM NATURAL FREQUENCY =,F10.5/       SHCH 21         11       SOM NATURAL FREQUENCY =,F10.5/       SHCH 21         12       SOM DAMPING RATIO = ,F10.5////       SHCH 21         13       SOM DAMPING RATIO = ,F10.5////       SHCH 22         14 <td>FORMAT</td> <td>(611)</td> <td>SHO</td> <td>Сн</td> <td>20</td>	FORMAT	(611)	SHO	Сн	20
1       32H NUMBER OF EARTHQUAKE RECORDS = ,I5/       SHCH 20         2       32H INTENSITY (CM**2/SEC**3) = ,F10.5/       SHCH 21         3       32H DURATION OF RECORDS (SECS) = ,F10.5/       SHCH 21         4       32H TIME INCREMENT (SECS) = ,F10.5/       SHCH 21         5       32H OUTPUT CONTROL ARRAY = ,611///       SHCH 21         6       33H HIGH FREQUENCY FILTER PROPERTIES //       SHCH 21         7       20H NATURAL FREQUENCY =,F10.5/       SHCH 21         8       20H DAMPING RATIO = ,F10.5////       SHCH 21         9       33H LOW FREQUENCY =,F10.5/       SHCH 21         5       20H NATURAL FREQUENCY =,F10.5/       SHCH 21         9       33H LOW FREQUENCY =,F10.5/       SHCH 21         5       20H NATURAL FREQUENCY =,F10.5/       SHCH 21         5       20H NATURAL FREQUENCY =,F10.5/       SHCH 21         5       20H DAMPING RATIO = ,F10.5////       SHCH 22         5       20H DAMPING FUNCTION PARAMETERS //       SHCH 22         5       32H DURATION OF BUILD-UP = ,F10.5////       SHCH 22         5       32H DURATION OF BUILD-UP = ,F10.5////       SHCH 22         5       32H BUILD-UP CURVE = ,12/       SHCH 22         5       32H EXPONENTIAL DECAY CONSTANT = ,F10.5////) <t< td=""><td>EDRMATI</td><td>141.844//</td><td>SHC</td><td>ĹН</td><td>20</td></t<>	EDRMATI	141.844//	SHC	ĹН	20
232H INTENSITY (CM**2/SEC**3) = ,F10.5/SHCH 21332H DURATION OF RECORDS (SECS) = ,F10.5/SHCH 21432H TIME INCREMENT (SECS) = ,F10.5/SHCH 21532H OUTPUT CONTROL ARRAY = ,611////SHCH 21633H HIGH FREQUENCY FILTER PROPERTIES //SHCH 21720H NATURAL FREQUENCY =,F10.5/SHCH 21820H DAMPING RATIO = ,F10.5////SHCH 21933H LOW FREQUENCY =,F10.5/SHCH 21520H NATURAL FREQUENCY =,F10.5/SHCH 21933H LOW FREQUENCY =,F10.5/SHCH 21520H DAMPING RATIO = ,F10.5////SHCH 21520H DAMPING RATIO = ,F10.5////SHCH 21520H DAMPING RATIO = ,F10.5////SHCH 22520H DAMPING RATIO = ,F10.5////SHCH 22532H DURATION OF BUILD-UP= ,F10.5////532H DURATION OF BUILD-UP= ,F10.5////532H TIME AT BEGINNING OF DECAY = ,F10.5/SHCH 22532H EXPONENTIAL DECAY CONSTANT = ,F10.5////SHCH 225SHCH 22SHCH 22532H EXPONENTIAL DECAY CONSTANT = ,F10.5////SHCH 22	1	32H NUMBER OF FARTHQUAKE RECORDS = .15/	SHO	Сн	20
3       32H DURATION OF RECORDS (SECS) = ,F10,5/       SHCH 21         4       32H TIME INCREMENT (SECS) = ,F10.5/       SHCH 21         5       32H QUTPUT CONTROL ARRAY = ,611////       SHCH 21         6       33H HIGH FREQUENCY FILTER PROPERTIES //       SHCH 21         7       20H NATURAL FREQUENCY =,F10.5/       SHCH 21         8       20H DAMPING RATIO = ,F10.5////       SHCH 21         9       33H LOW FREQUENCY FILTER PROPERTIES //       SHCH 21         9       33H LOW FREQUENCY =,F10.5/       SHCH 22         9       33H LOW FREQUENCY =,F10.5/       SHCH 22         9       32H BUILD-UP CURVE = ,F10.5/       SHCH 22         9       32H BUILD-UP CURVE = ,I2/       SHCH 22         9       32H EXPONENTIAL DECAY CUNSTANT = ,F10.5////)       SHCH 22         9       32H EXPONENTIAL DECAY CUNSTANT = ,F10.5////)       SHCH 22	2	32H INTENSITY (CM**2/SEC**3) = .610.5/	SHC	Сн	21
4       32H TIME INCREMENT (SECS) = ,F10.5/       SHCH 21         5       32H QUTPUT CONTROL ARRAY = ,611////       SHCH 21         6       33H HIGH FREQUENCY FILTER PROPERTIES //       SHCH 21         7       20H NATURAL FREQUENCY =,F10.5/       SHCH 21         8       20H DAMPING RATIO = ,F10.5////       SHCH 21         9       33H LOW FREQUENCY FILTER PROPERTIES //       SHCH 21         9       33H LOW FREQUENCY =,F10.5/       SHCH 21         9       33H DOW FREQUENCY =,F10.5/       SHCH 21         9       33H DOW FREQUENCY =,F10.5/       SHCH 21         9       33H DOW FREQUENCY =,F10.5/       SHCH 21         9       34H DURATION OF BUILD-UP       =,F10.5////       SHCH 22         9       32H DURATION OF BUILD-UP       =,F10.5/       SHCH 22         9       32H DURATION OF DECAY = ,F10.5/       SHCH 22         9       32H EXPONENTIAL DECAY CONSTANT =,F10.5////       SHCH 22         9       32H EXPONENTIAL DECAY CONSTANT =,F10.5////       SHC	3.	32H DURATION OF RECORDS (SECS) = .F10.5/	SHC	Сн	21
5       32H DUTPUT CONTROL ARRAY       = ,611////       SHCH 21         6       33H HIGH FREQUENCY FILTER PROPERTIES //       SHCH 21         7       20H NATURAL FREQUENCY =,F10.5/       SHCH 21         8       20H DAMPING RATIO       = ,F10.5////       SHCH 21         9       33H LOW FREQUENCY FILTER PROPERTIES //       SHCH 21         9       33H LOW FREQUENCY =,F10.5/       SHCH 21         9       34H DAMPING RATIO       =,F10.5////       SHCH 22         9       32H DURATION OF BUILD-UP       =,F10.5/       SHCH 22         9       32H DURATION OF BUILD-UP       =,F10.5/       SHCH 22         9       32H TIME AT BEGINNING OF DECAY       =,F10.5////       SHCH 22         9       32H EXPONENTIAL DECAY CONSTANT       =,F10.5////       SHCH 22         9	4	32H TIME INCREMENT (SECS) = .F10.5/	SHC	Сн	21
6       33H HIGH FREQUENCY FILTER PROPERTIES //       SHCH 21         7       20H NATURAL FREQUENCY =,F10.5/       SHCH 21         8       20H DAMPING RATIO       = ,F10.5////       SHCH 21         9       33H LOW FREQUENCY FILTER PROPERTIES //       SHCH 21         9       33H LOW FREQUENCY =,F10.5/       SHCH 21         9       30H DAMPING RATIO       = ,F10.5////       SHCH 22         9       32H DURATION OF BUILD-UP       = ,F10.5////       SHCH 22         9       32H BUILD-UP CURVE       = ,12/       SHCH 22         9       32H EXPONENTIAL DECAY CONSTANT       =,F10.5////       SHCH 22         9       32H EXPONENTIAL DECAY CONSTANT       =,F10.5////       SHCH 22         9       32H EXPONENTIAL DECAY CONSTANT	5	32H OUTPUT CONTROL AKRAY = ,611////	SHC	Эн	21
720H NATURAL FREQUENCY =,F10.5/SHCH 21820H DAMPING RATID= ,F10.5////SHCH 21933H LOW FREQUENCY FILTER PRUPERTIES //SHCH 21933H LOW FREQUENCY =,F10.5/SHCH 2120H DAMPING RATID= ,F10.5/SHCH 2120H DAMPING RATID= ,F10.5////SHCH 2120H DAMPING RATIO= ,F10.5////SHCH 2220H DAMPING FUNCTION PARAMETERS //SHCH 2232H DURATION OF BUILD-UP= ,F10.5/SHCH 2232H BUILD-UP CURVE= ,12/SHCH 2232H TIME AT BEGINNING OF DECAY= ,F10.5////SHCH 2232H EXPONENTIAL DECAY CUNSTANT= ,F10.5////SHCH 22SHCH 23SHCH 24SHCH 22SHCH 24SHCH 24SHCH 22SHCH 25SHCH 24SHCH 24	6	33H HIGH FREQUENCY FILTER PROPERTIES //	SHC	ίн	21
8       20H DAMPING RATIO       = ,F10.5////       SHCH 21         9       33H LOA FREQUENCY FILTER PROPERTIES //       SHCH 21         \$       20H NATURAL FREQUENCY =,F10.5/       SHCH 21         \$       20H DAMPING RATIO       = ,F10.5////       SHCH 21         \$       20H DAMPING RATIO       = ,F10.5////       SHCH 21         \$       20H DAMPING RATIO       = ,F10.5////       SHCH 21         \$       20H DAMPING RUCTION PARAMETERS //       SHCH 22         \$       32H DURATION OF BUILD-UP       = ,F10.5/       SHCH 22         \$       32H BUILD-UP CURVE       = ,12/       SHCH 22         \$       32H TIME AT BEGINNING OF DECAY       = ,F10.5////       SHCH 22         \$       32H EXPONENTIAL DECAY CONSTANT       = ,F10.5////       SHCH 22         \$       32H EXPONENTIAL DECAY CONSTANT       = ,F10.5////       SHCH 22         \$       32H EXPONENTIAL DECAY CONSTANT       = ,F10.5////       SHCH 22         \$       32H EXPONENTIAL DECAY CONSTANT       >,F10.5////       SHCH 22         \$       \$       \$       \$       \$         \$       \$       \$       \$       \$         \$       \$       \$       \$       \$	7	ZOH NATURAL FREQUENCY =, F10.5/	SHC	Сн	21
9       33H LOW FREQUENCY FILTER PROPERTIES //       SHCH 21         \$       20H NATURAL FREQUENCY =,F10.5/       SHCH 21         \$       20H DAMPING RATIO       = ,F10.5////       SHCH 21         \$       20H DAMPING RATIO       = ,F10.5////       SHCH 21         \$       20H DAMPING RATIO       = ,F10.5////       SHCH 21         \$       20H DAMPING FUNCTION PARAMETERS //       SHCH 22         \$       32H DURATION OF BUILD-UP       = ,F10.5/       SHCH 22         \$       32H BUILD-UP CURVE       = ,12/       SHCH 22         \$       32H TIME AT BEGINNING OF DECAY       = ,F10.5//       SHCH 22         \$       32H EXPONENTIAL DECAY CUNSTANT       = ,F10.5////)       SHCH 22         \$       32H EXPONENTIAL DECAY CUNSTANT       = ,F10.5////)       SHCH 22         \$       SHCH 20.5////)       SHCH 22       SHCH 22         \$       SHCH 20.5////>SHCH 22       SHCH 22       SHCH 22	8	20H DAMPING RATIO = "F10.5////	SHC	Сн	21
S       20H NATURAL FREQUENCY =,F10.5/       SHCH 21         S       20H DAMPING RATIO =,F10.5////       SHCH 21         S       28H SHAPING FUNCTION PARAMETERS //       SHCH 22         S       32H DURATION OF BUILD-UP =,F10.5/       SHCH 22         S       32H BUILD-UP CURVE =,I2/       SHCH 22         S       32H TIME AT BEGINNING OF DECAY =,F10.5/       SHCH 22         S       32H EXPONENTIAL DECAY CONSTANT =,F10.5////)       SHCH 22         SHCH 22       SHCH 22       SHCH 22         S       32H EXPONENTIAL DECAY CONSTANT =,F10.5////)       SHCH 22         SHCH 22       SHCH 22       SHCH 22	9	33H LOW FREQUENCY FILTER PROPERTIES //	SHC	H	21
\$       20H DAMPING RATIO       = ,F10.5////       SHLH       21         \$       28H SHAPING FUNCTION PARAMETERS //       SHCH       22         \$       32H DURATION OF BUILD-UP       = ,F10.5/       SHCH       22         \$       32H BUILD-UP CURVE       = ,I2/       SHCH       22         \$       32H TIME AT BEGINNING OF DECAY       = ,F10.5/       SHCH       22         \$       32H EXPONENTIAL DECAY CONSTANT       = ,F10.5////)       SHCH       22         \$       32H EXPONENTIAL DECAY CONSTANT       = ,F10.5////)       SHCH       22         \$       32H EXPONENTIAL DECAY CONSTANT       = ,F10.5////)       SHCH       22         \$       SHCH       SHCH       22       SHCH       24	\$	20H NATURAL FREQUENCY =, F10.5/	SHC	CH	21
\$ 28H SHAPING FUNCTION PARAMETERS //       SHCH 22         \$ 32H DURATION OF BUILD-UP       = ,F10.5/       SHCH 22         \$ 32H BUILD-UP CURVE       = ,12/       SHCH 22         \$ 32H TIME AT BEGINNING OF DECAY       = ,F10.5/       SHCH 22         \$ 32H EXPONENTIAL DECAY CONSTANT       = ,F10.5////)       SHCH 22         SHCH 22       SHCH 22       SHCH 22         \$ 32H EXPONENTIAL DECAY CONSTANT       = ,F10.5////)       SHCH 22         \$ HCH 22       SHCH 22       SHCH 22         \$ HCH 22       SHCH 22       SHCH 22	\$	20H DAMPING RATIO = ,F10.5////	Sni	чH	21
\$ 32H DURATION OF BUILD-UP       = ,F10.5/       SHCH 22         \$ 32H BUILD-UP CURVE       = ,I2/       SHCH 22         \$ 32H TIME AT BEGINNING OF DECAY       = ,F10.5/       SHCH 22         \$ 32H EXPONENTIAL DECAY CONSTANT       = ,F10.5////)       SHCH 22         SHCH 22       SHCH 22	\$	28H SHAPING FUNCTION PÄRAMETERS //	SHC	Сн	22
\$ 32H BUILD-UP CURVE       = ,12/       \$ SHCH 22         \$ 32H TIME AT BEGINNING OF DECAY       = ,F10.5/       \$ SHCH 22         \$ 32H EXPONENTIAL DECAY CONSTANT       = ,F10.5////)       \$ SHCH 22         \$ BND       \$ SHCH 22       \$ SHCH 22         \$ SHCH 22       \$ SHCH 22       \$ SHCH 22         \$ SHCH 22       \$ SHCH 22       \$ SHCH 22	\$	32H DURATION OF BUILD-UP = ,F10.5/	SHC	ĻΗ	22
\$ 32H TIME AT BEGINNING OF DECAY = ,FL0.5/       SHGH 22         \$ 32H EXPONENTIAL DECAY CONSTANT = ,FL0.5////)       SHGH 22         END       SHGH 22         SHGH 22       SHGH 22	\$	32H BUILD-UP CURVE = ,12/	SHC	ũн	22
SUBDOUTING CHADE (D. D.) NU NDEC)	\$	32H TIME AT BEGINNING OF DECAY = ,F10.5/	SH(	Gн	22
	\$	32H EXPONENTIAL DECAY CONSTANT = $,F10.5////)$	SHC	H	22
	END		SHC	н	22
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JUDROUIINE JHAFE (FIFIIIIIIIUEC)	3.1.3.1	~ ~ ~
	SHCH	227
* * * * * * * * * * * * * * * * * * * *	SHCH	228
	SHCH	229
SHAPING FUNCTION FOR INITIAL PARABULIC OR CUBIC BUILD-UP	SHCH	230
-	SHCH	231
* * * * * * * * * * * * * * * * * * * *	SHCH	232

С SHCH 233 COMMON /CNTRL/ NEQREC, T, DT, EAMAX, DAMP, FO, TI, TO, CE2, NOUT(5), HED(8) SHCH 234 1, NEQ, ISHAPE, ACCMAX(40), VELMAX(40), DISMAX(40) SHCH 235 SHCH 230 DIMENSION P(1), P1(1) IF (NI) 3,3,1 SHCH 237 1 CDEFF=(DT/TI)\*\*ISHAPE SHCH 238 SHCH 239 00 2 N=1.NI SHCH 240 F=N\*\*ISHAPE SHCH 241 2 P1(N)=F\*COEFF 3 CONTINUE SHCH 242 SHCH 243 С č SHCH SHAPING FUNCTION FOR EXPONENTIAL DECAY 244 SHCH 245 C SHCH IF (NDEC) 6,0,4 246 4 CE2=-CE2#DT SHCH 247 DJ 5 N=1,NDEC SHCH 248 SHCH 249 F=N SHCH 250 5  $P(x) = EXP(CE2 \neq F)$ 6 RETURN SHCH 251 END SHCH 252

SUDROUTINE GEN (P, P1, ACC, VEL, DISP) SHCH 253 SHCH 254 \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* SHCH 255 ¢ SHCH 256 257 SHCH PSEUDU EARTHQUAKE GENERATION SHCH 258 SHCH 259 \* + \* SHCH 260 SHCH DIMENSION P(1), P1(1), ACC(1), VEL(1), DISP(1) 261 COMMON /GENC/ PI2, NO, NI, NOEC, NTOT, AMPL, D1, D2, D3, D4, WU, D, C, SHCH 262 A1, A2, A3, A4, A5, A0, A7, CL, DL, NACC, NVEL SHCH 263 l COMMON /CNTRL/ NEGREC, T, DT, EAMAX, DAMP, FO, TI, TO, CE2, NOUT (0), HED(8) SHCH 264 1, NE J, ISHAPE, ACCMAX(40), VELMAX(40), DISMAX(40) SHCH 265 SHCH 266 SHCH 267 INITIAL CONDITIONS SHCH 268 SHCH 269 J=1 SHCH 270 2=3.0 SHCH 271 20=0.0 SHCH 272 200=0.0 ZL=0.0 SHCH 273 ZDL=0.0 SHCH 274 SHCH 275 200L=0.0 SHCH 276 F=0.0 SHCH AG1=0.0 277 V=J.0 SHCH 278 SHCH 279 51=0.0 SHCH 280 52=0.0SHCH 281 \$3=0.0 SHCH 282 DISP(1)=0.0 VEL(1)=0.0 SHCH 283 ACC(1)=0.0 SHCH 284 SHCH 285 SHCH 286 00 8 N=2,NTOT SHCH 287 . SHCH 288 WHITE NOISE

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,					· · ·		
							· .
						SHCH	289
	•	CO TO (1-2).				SHCH	- 290
r	•		* * * * * * * * * * * * *	* * * * *		SHCH	291
			CENERATION EINCTION	***		SHCH	292
		AT EACH CALLS IT OFTIDALS A DAMA	LINE NUMBER SETSEEN O D AND	i a		SHCH	293
		AF EACH GALL IT REFORMS A RAND	+ $+$ $+$ $+$ $+$ $+$ $+$ $+$ $+$ $+$			SHCH	294
	•	$\mathbf{y}_{1} + \mathbf{p}_{ANE}(\mathbf{y}_{1}) = \mathbf{y}_{1}$		• • • • •		SHEM	295
	1	¥ 2=012=0ANE(0.0)				SHCH	266
· · · ·		AZ=P1Z=RANF(U+U)				SHCH	297
		A1ALUGIA17 V1+C.\QT/V14V1)				SHCH	208
						SHCH -	230
						SHCH	300
		.CO TO 3			÷ 1	SHCH	301
•						SHCH	302
						SHCH	303
	-					SHCH	304
						SHCH	305
		SHAPE THE WHITE NOISE				SHCH	306
						SHCH	307
	-					SHCH	308
		IF-(1) 4.5.5				SHCH	309
		b H=H+PI[N]				SHCH	310
		5 CONTINUE				SHCH	311
		I=N-NO			*	SHCH	312
		IF (1) 7,7,6				SHCH	313
		5 W=W+P(I)		·		SHCH	314
	:					SHCH	315
C		FILTER THE SHOT NOISE	· · ·			SHCH	310
(	2					SHCH	317
	7	A=A1+Z+A2+ZD+ZDD+ZDD				SHCH	318
-		B=A3+Z+ZD+ZD+A4+ZDD		. ·		SHCH	319
		Z={A-w+D+B}/C	· · ·			SHCH	320
·• .		2D=A3+2-8				SHCH	321
		ZDD=A1+Z-A				SHCH	322
		w=w+ZDD				SHCH	323
- 1. C					· · · · ·	SHCH	324
0		LOW FREQUENCY FILTER			•	SHCH	325
	•.					SHCH	326
			•			SHEH	341
						SHOR	340
		26418-8702-01/66	· ·			SHUL	320 .
• •						SHICH	221
						SHER	333
. (	• ·	RG-EDDE				SHCH	333
	-	RASELINE CORRECTION FACTORS				SHCH	334
	_	DASECTAL CONNECTION TROTONS		•		SHCH	335
		C1=F+.5				SHCH	330
		C2=E/0_+.125				SHCH	337
		C3=F/3.+5./24.	,			SHCH	338
		S1=S1+C1+V+(C2+AG+C3+AG1)+DT				SHCH	339
	•	F2=F*F				SHCH	340
		C1=F2+F+1./3.				SHCH	341
		C2=F2/6.+F/4.+0.1				SHCH	342
•		C3=F2/3.+F/2.4+.15				SHCH	343
		S2=S2+C1=V+(C2=AG+C3=AG1)=DT				SHCH	344
		F3=F+F2				SHCH	345
		C1=F3+1.5*F2+F+.25				SHCH	346
		C2=F3/6.+.375*F2+.3*F+1./12.				SHCH	347
		C3=F3/3.+.625*F2+.45*F+7./60.				SHCH	348

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S3=S3+C1+V+{C2+AG+C3+AG1}+DT F=F+1. V=V+(AG+AG1)\*A4 AG1=AG ACC(N)=AG 8 CONTINUE

## BASELINE CORRECTION COEFFICIENTS 81=D2\*S1 82=D3\*S2

```
B3=D4+S3
C1=-300.*81+900.*82-630.*83
C2=1800.*B1-5760.*B2+4200.*B3
C3=-1890.+81+6300.+82-4725.+83
```

BASELINE CORRECTIONS AND MAXIMUM VALUES

```
ACCMAX(NEQ)=0.0
   VELMAX(NEQ)=0.0
  DISMAX(NEQ)=0.0
   X1 = 0.0
   DU 9 N=2,NTOT
   X1 = X1 + D1
   ACC(N)=(ACC(N)+C1+C2*X1+C3*X1*X1)*AMPL
   CALL AVDMAX(ACC(N), ACCMAX(NEQ))
   VEL(N)=VEL(N-1)+(ACC(N)+ACC(N-1))*A7
   CALL AVDMAX(VEL(N),VELMAX(NEQ))
   DISP(N)=DISP(N-1)+VEL(N-1)*DT+ACC(N-1)*A6+ACC(N)*A5
   CALL AVDMAX(DISP(N), DISMAX(NEQ))
9 CONTINUE
   PRINT 10. NEQ
10 FORMAT(1H ,/////
          28H ACCELERATION RECORD NUMBER ,121
  1
   PRINT 11, ACCMAX(NEQ), VELMAX(NEQ), DISMAX(NEQ)
11 FORMATCH ,/
          36H MAXIMUM ACCELERATION(CM/SEC**2) =
36H MAXIMUM VELOCITY(CM/SEC) =
                                                    ,F7.2/
  1
                                                     ,F7.2/
  Ł
                                                     ,F7.2)
          36H MAXIMUM DISPLACEMENT(CM)
                                                  .
  1
   RETURN
```

SHCH 390 SUBROUTINE OUT (ACC, VEL, DISP, NTOT) SHCH 391 SHCH 392 \* \* \* \* \* \* \* \* \* \* \* \* \* \* SHCH 393 SHCH PRINT AND PUNCH RECORDS 394 SHCH 395 SHCH 390 397 SHCH SHCH COMMON /CNTRL/ NEQREC, T, DT, EAMAX, DAMP, FO, TI, TO, CE2, NOUT (6), HED (8) 398 SHCH 399 1,NEQ,ISHAPE,ACCMAX(40),VELMAX(40),DISMAX(40) DIMENSION ACCINTOT), VELINTOT), DISPINTOT) SHCH 400 SHCH 401 DT5=5.\*DT SHCH 402 IF (NOUT(1).NE.0) GO TO 1 SHCH 403 PRINT 7, HED, NEQ SHCH 404 CALL PRIN (ACC, NTOT, DT5)

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END

1 IF (NOUT(2).NE.O) GO TO 2		SHCI	н 4
PRINT 8, HED, NEW		SHU	n 4
CALL PRIN (VEL, NTOT, DT5)		SHC	н 4
2 IF (NOUT(3).NE.0) GO TO 3		SHCI	H. 4
PRINT 9, HED, NEW		SHCI	H .4
CALL PRIN (DISP,NTUT,DT5)		SHCI	H 4
3 IF (NOUT(4).NE.0) GO TO 4		SHC+	H 4
PUNCH 11, HED, NEQ, NTOT, DT		SHCI	Н 4
PUNCH 10, (ACC(I),I=1,NTUT)		SHC	n 4
4 IF (NOUT15).NE.0) GO TO 5	•	SHCI	н 4
PUNCH 12, HED, NEQ, NTUT, DT		SHCH	Н 4
PUNCH 10, (VEL(1), [=1,NTUT)		SHCI	H · 4
5 IF (NOUT(6).NE.0) GO TO 0		SHCI	н 4
PUNCH 13, HED, NEQ, NTOT, DT		SHC	H 4
PUNCH 10. (DISP(I), I=1, NTUT)		SHC	н 4
6 CONTINUE		SHG	н 4
RETURN		SHCi	H 4
		SHCI	н 4
7 FORMAT LIHI.844.5X.26HACCELERATION R	LECORD NUMBER 13//	SHC	H 4
1 6X.4HTIME.5(4X.16HACCN (CM/S	EC##2)))	SHCI	н 4
8 FORMAT (1H1.844.5X.22HVELOCITY RECOR	D NUMBER-13//	SHC	н 4
1 6X.4HTINE.5L8X.12HVEL (CM/SE	-()))	SHC	н
9 FORMAT (1H).844.5%.26HD[SPLACEMENT R	LECORD NUMBER 13//	SHCI	н 4
1 6X. AHTIME. 5(11X. 9HDISP (CN))	1	SHC	ни
IN FORMAT (SEID.4)	•	SHC	н
11 FORMAT (BA4.12H ACCN RECORD.13.7H N	PTS=.15.5H DT=.E5.3)	SHO	H 4
12 FORMAT (BAG.12H VEL RECORD.13.7H N	$PT_{3}, T_{3}, 5H = DT_{3}, F_{3}, 3$	SHC	ни
. 12 SORMAT (244.12H DISD BECORD, 13.7H N	IPTS=:(5.5H 0T=:65*3)	SHCI	н 4
END		SHC	н 4
		3.161	
SUBROUTINE PRIN (A.NTUT.DT5)		SHC	н
	1	SHC	н
* * * * * * * * * * * * * * * * * * *	* * * * * * * * * * * * * *	SHU	н
		SHC	н
PRINT RECORDS	· · · · · · · · · · · · · · · · · · ·	SHCI	н
		SHC	н
	* * * * * * * * * * * * * * * * *	SHCI	A :
		SHE	н
DIMENSION AUNTOTI	· · · · · · · · · · · · · · · · · · ·	SHC	н.
	· · · · · · · · · · · · · · · · · · ·	SHC	, 
N2=5		SHC	H 6
11=0		SHCL	нь
1 DD INT 2. TT. (A(I), J+N1, N2)	,	SHCI	ы
IE INDEA NTATI DETIEN		SUCE	ни
IF INZOEVONIUII KEIUKN Ni-Niiks		S1101	л : ы ,
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S FORMAT JELO S ADECSO SA		2HU1	лі • ц
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SUBROUTINE AVDMAX(A,8)

SHCH 456

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SHCH 457 С \* \* \* \* \* \* \* SHCH C \* \* \* \* 458 č SHCH 459 SHCH С DETERMINATION OF MAXIMUM VALUE 460 SHCH 461 С SHCH С \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* ۰ de 462 \* \* Ĉ SHCH 463 X=485(4) SHCH 464 SHCH 465 IF(X.GT.B) B=X SHCH RETURN 466 END SHCH 467 SHCH -SUBROUTINE ORIGIN(ZZ,MJSKE,TH,ZMAX) 468 SHCH С 469 SHCH 470 \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* C С SHCH 471 Ĉ NONLINEAR RESPONSE ANALYSIS FOR ORIGIN-ORIENTED MODEL SHCH 472 473 SHCH C SHCH 474 C SHCH 475 С PROGRAMMER. . M.MURAKAMI 1975 SHCH 476 C č SHCH 477 \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* SHCH 478 ¢ INPUT DATA SHCH 479 С SHCH 480 С Č NAME1 NAME OF MODEL SHCH 481 С **T**1 INITIAL NATURAL PERIOD (SEC) SHCH 482 CRACKING STRENGTH IN TERMS OF BASE SHEAR COEFFICIENT X1STR SHCH 483 С ULTIMATE STRENGTH IN TERMS OF BASE SHEAR COEFFICIENT SHCH 484 ¢ X2STR SHCH С DAMP DAMPING RATIO 485 С AMAX AVERAGE OF MAXIMUM ACCELERATION IN TERMS OF GRAVITY SHCH 486 NUMBER OF TI INCREASED IN GEOMETRICAL RATIO SHCH 487 ID С (SQRT[2.0]) SHCH 488 С SHCH С 489 Ċ SHCH 490 SHCH 491 С SHCH EARTHQUAKE ACCELEROGRAM 492 С ZZ SHCH MJSKE NUMBER OF DATA OF EARTHQUAKE ACCELEROGRAM 493 С SHCH 494 C TH TIME INCREMENT ZMAX MAXIMUM ACCELERATION SHCH 495 С SHCH 496 С STIFFNESS OF EACH REGION SHICH C 61 497 CRACKING DISPLACEMENT SHCH 498 С XI(1)SHCH С X1(2) YIELDING DISPLACEMENT 499 SHCH 500 С \* SHCH 501 С SHCH 502 С IF LAST CARD IS "STOP" (COLUNN 1-4), SUBROUTINE RETURNS TO MAIN. SHCH 503 С SHCH С 504 С SHCH 505 SHCH 506 С SHCH 507 DIMENSION NAME1(8), B1(3), X1(2), ZZ(MJSKE), DXE(2). SHCH 508 DATA KAERE/4HSTOP/ 1000 READ 100, NAME1 SHCH 509 IF (NAME1(1).EQ.KAERE) GO TO 9999 SHCH 510 READ 102, TL, XISTR, DAMP, AMAX, ID SHCH 511 SHCH 512 X2STR=1.9\*X1STR

REDUCT=0.19	SHC	H 513
00 1 II=1,ID	- SHL	H 514
IIRR=II-1	SHL	H 515
TL=T1+SQRT(2,0)++IIRK	SHC	H 516
PRINT 104, NAMEL, AMAX, XISTR, X2STK,	REDUCT, DAMP SHC	H 517
B1{1}={6.283185/T1}=*2	SHC	H 518
B1(2)=REDUCT*B1(1)	SHC	H 519
BX=980.+(X2STR-X1STR)	SHC	H 520
X1(1)=980.*X1STR/61(1)	SHC	H 521
X1(2)=980.=X2STR/81(2)	SHC	H 522
$B1{2}=BX/(X1{2}-X1{1})$	SHC	H 523
B1(3)=0.001*B1(2)	SHC	н 524
NSTEP=1	SHC	H 525
IF(II.GI.2) NSTEP=2	SHC	H 526
DELTAT=TH*FLOAT(NSTEP)	SHC	н 527
PRINT 106, T1, DELTAT, X1	SHC	H 528
Ad=81(1)	SHC	H 529
$AR = 2 \cdot APP + SQRT(AB)$	SHC	H 530
LLL=1	SHC	H 531
IUA=8	SHC	H 532
IF(II.GT.5) IUA=4	SHC	H 533
IF(11.GT.7) 10A=2	SHC	H 534
A2=0.0	SHC	H 535
V2=0.0	SHC	h 53o
D2=0.0	SHC	H 537
VV2=0.0	SHC	н 538
DUMAX=0.0	SHC	H 539
DXE(1) = X1(1)	SHC	H 540
DXE(2)=X1(2)	SHC	H 541
K2=1	SHC	H 542
GG≠IDA	SHC	H 543
DT=DELTAT/GG	SHC	H 544
	SHC	H 545
RESPONSE ANALYSIS	SHC	H 546
	SHC	H 547
DO 2 I=1,MJSKE,NSTEP	SHC	H. 540
A1=A2	SHC	H 549
. VI=V2	SHC	H 550
01=02	SHC	H 551
VV1=VV2	SHC	H 552
K1=K2	ŚHC	H 553
IF(I.NE.1) GO TÚ 10	SHC	H 554
ZZZZZZ=ZZ(1)	, SHC	H 555
GO TO 15	SHC	н 556
O III=I-NSTEP	SHC	H_ 557
222222=22(1)-22(111)	SHC	н 558
5 CONTINUE	SHC	H 559
ZZZZZ=980 .+ZZZZZ*AMAX/ZMAX	SHC	H 500
CALL RESPI (ZZZZZZ, AZ, AR, AB, A1, VI,	,D1,DELTAT,V2,D2,VV2,LLL) SHC	H 561
LLL=0	SHC	H 562
IF(I-1) 20,25,20	SHC	н 563
O CONTINUE	SHC	H 564
	SHC	H 505
JUDGE FOR CHANGE OF POSITION	SHC	H 506
	SHC	H 567
CALL MASAEVV1.VV2.D2.DXE.K1.LLL	SHC	H 5od
IF(LLL) 30,25,30	SHC	H 509
5 CONTINUE	SHL	H 570
CALL AVDMAY(D2.DOMAX)	SHC	H 571

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		6464	
30		SHUT	213
С		SHCH	274
С	RESPONSE ANALYSIS FOR SUBDIVIDED INTERVAL	SHCH	575
С		· · · SHCH	576
	DO 3 1A=1.10A	SHCH	571
	IE # 1 A- 1 ) 40-45-40	SHCH	578
40		SHCH	579
40		CHCH	590
	AL-AZ	SHCH	500
		anch	201
	01=02	SHCH	582
	VVI=VV2	SHCH	583
	K1=K2	SHCH	584
46	5 CONTINUE	SHCH	585
		SHCH	586
		SHCH	597
~		curcu	501
C		3000	208
C	JUDGE FOR CHANGE OF PUSITION AND DETERMINATION UP STIFFNESS	SHCH	287
С		SHCH	590
	CALL JUNKU(BI,AB,X2STR,VVI,VV2,D2,DXE,K1,K2,LLL)	SHCH	591
	[F(LLL) 50,55,50	SHCH	592
50	CONTINUE	SHCH	593
		SHCH	594
		SHCH	505
	CALL AVDMAX(D2,DOMAX)	SHCH	595
	GU 10 3	SHUH	290
55	5 CONTINUE	SHCH	597
	CALL AVDMAX(D2,D3MAX)	SHCH	598
3	3 CONTINUE	SHCH	599
	111=1	SHCH	600
2	CONTINUE	SHCH	601
-		SHCH	602
		CHCH	402
_	PRINI 108, DUMAX, DUCI	SHCH	003.
1	L CONTINUE	SHCH	604
	GO TO 1000	SHCH	605
100	D FORMAT(844)	SHCH	600
102	2 FORMAT(4F8.0.14)	SHCH	607
104	EDRMAT (1H1-844//	SHCH	<b>b</b> 08
101	THE SECOND THE ACCOUNT	SHCH	609
	1 330 AVERAGE OF MAXIMUM ACCLERATION - (10-3)	SHCH	610
	2 337 URAUNING SHEAK STRENGTH $ f(0.5)$	SHOL	411
	3 35H ULTIMATE SHEAK STRENGTH = ,FO+3/	SHOW	011
	4 35H RATIO OF K2 TO KI (REDUCTION) = +F6-37	SHCH	012
	5 35H DAMPING RATIO = ,Fo.3//)	SHCH	613
106	6 FORMAT (1H ,/	SHCH	614
	1 25H NATURAL PERIOD - + ,F8+3/	SHCH	615
	2 25H TIME INCREMENT * F8-3/	SHCH	616
	3 25H CRACKING DISPLACEMENT = FR. 3.2X. 3HCM /	SHCH	617
	2 25. UNITABLE DIGLIGUIGHT = EQ 292 200 //)	Can H	618
	4 ZON ULIIMAIE UISPLAGEMENI - JPO-JJZAJONCH ///	CUCU	6 J G
105	DEFUKMAL LED 1/	anun Cucu	967 430
	1 Z4H MAXIMJM DISPLACEMENT = +F10.3+2X+3HCM /	SUCH	020
	2 24H DUCTILITY FACTUR NT = $F10.3//$	2HCH	621
9999	9 RETURN	SHCH	622
	ÊND	SHCH	623
			-
	SUBPOUTTNE HINKO (B1.4B.X2STR.V).V2.02.0XF.K1.K2.K)	SHICH	626
<u>د</u>	SORGOTIAL ADAKO IDIANDAKEJIKIALIALIALIALIALIALIALIALIALIALIALIALIALI	CHUC IN	626
L A			- 3 é
C A	* * * * * * * * * * * * * * * * * * * *	31261	970
6		anun	021
С	SELECTION OF STIFFNESS AT NEXT STEP	SHCH	026

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-SHCH 629 C SHCH 630 INPUT DATA SHCH 631 STIFFNESS OF EACH REGION SHCH 632 С **B1** ULTIMATE STRENGTH IN TERMS OF BASE SHEAR COEFFICIENT SHCH 033 С X2STR INCREMENTAL DISPLACEMENT AT LAST STEP SHCH С V1 034 С ٧2 INCREMENTAL DISPLACEMENT SHGH 635 RELATIVE DISPLACEMENT SHCH C D2 030 ORIGINAL OR MODIFIED DISPLACEMENT CURRESPONDING TU SHCH 637 С DXE BREAK-PUINT SHCH С 638 C K1 INDEX FOR POSITION SHCH 639 C SHCH 640 OUTPUT DATA SHCH. 641 C SHCH 642 С STIFFNESS AT NEXT STEP SHCH C AB 643 INDEX FOR POSITION AT NEXT STEP C SHCH 644 K2 INDEX FOR CHANGE OF POSITION K=0 NUN SHCH С κ 645 SHCH C 646 SHCH \* \* C 647 С SHCH 648 DIMENSION DXE(2), B1(3) SHCH 649 IF(V1+V2) 10,10,20 SHCH 650 SHCH 651 10 IF (K1.EQ.1) GO TO 30 Z=ABS(D2) SHCH D52 IF(K1-2) 40,40,50 SHCH 653 40 ST=B1(1)+DXE(1) SHCH 654 GO TO 60 SHCH 655 50 ST=980.\*X2STR SHCH 656 60 ST=ST+B1(K1)\*(Z-DXE(K1-1)) SHCH 657 AB=ST/Z SHCH 658 B1(1)=A8 SHCH 659 SHCH DXE(1)=Z 660 K2=1 SHCH 601 K=1 SHCH 662 GO TO 30 SHICH 603 20 IF(K1.NE.1) GO TO 70 SHCH 664 SHCH 665 Z=ABS(D2) IF(Z.LT.DXE(1)) GO TO 30 SHCH 000 IF(Z.GT.DXE(2)) GO TO 80 SHCH 667 AB=81(2) SHCH 668 SHCH 609 K=2 K2=2 SHCH 67ü GO TO 30 SHCH 071 70 IF(K1.EQ.3) GO TO 30 SHLH 672 Z=ABS(D2) SHCH 673 IF(Z.LT.DXE(2)) GD TO 30 SHCH 674 80 K=3 SHCH 675 K2=3 SHCH 076 SHCH 677 AB=B1(3) SHCH 30 RETURN 678 SHCH 679 END SUBROUTINE MASA (V1+V2,D2,DXE,K1+K) SHCH 680 SHCH C 681 C \* \* \* \* \* \* \* \* ShCh 682 \* \* \* \* \* SHCH 683

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JUDGE FOR CHANGE OF POSITION

1 Ŧ. SHCH 685 С Ĉ INPUT DATA SHCH 680 SHCH 687 C Ċ ٧1 INCREMENTAL DISPLACEMENT AT LAST STEP SHCH 688 С ٧2 INCREMENTAL DISPLACEMENT SHCH 689 С SHCH D2 RELATIVE DISPLACEMENT 690 SHCH 691 C DXE ORIGINAL OR MODIFIED DISPLACEMENT CORKESPONDING TU **BREAK-PUINT** SHCH 692 С С SHCH 693 Ċ JUTPUT DATA SHCH 694 C SHCH 695 696 С INDEX FOR PUSITION SHCH K1 С ĸ INDEX FOR CHANGE OF PUSITION K=0 NUN SHCH 697 С SHCH 698 С \* \* \* \* \* \* \* \* \* \* \* \* \* \* SHCH 699 SHCH 700 С 701 SHCH DIMENSION DXE(2) IF(V1\*V2) 10,10,20 SHCH 702 10 IF(K1.EQ.1) GO TO 30 SHCH 703 SHCH 704 K=1 GO TO 30 SHCH 705 706 20 IF(K1.EQ.3) GU TO 30 SHCH Z=ABS(D2) SHCH 707 IF(Z.LT.DXE(K1)) GO TO 30 SHCH 708 SHCH 709 K ≈ 2 30 RETURN SHCH 710 END SHCH 711 SHCH 712 SUBROUTINE DTRILI(ZZ,MJSKE,TH,ZMAX) SHCH 7.13 C SHCH 714 C č SHCH 715 SHCH NONLINEAR RESPONSE ANALYSIS FOR DEGRADING TRI-LINEAR MODEL 716 C SHCH С 717 C SHCH 718 Ċ ORIGINALLY PROGRAMED BY UMEMURA LABORATORY (UNIVERSITY OF TOKYU) SHCH 719 MODIFICATIONS . . M.MURAKAMI 1975 SHCH 720 С SHCH С 721 С \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* \* SHCH 722 С SHCH 723 INPUT DATA SHCH C 724 č SHCH 725 NAME OF MODEL SHCH 726 С NAMEL INITIAL NATURAL PERIOD (SEC) SHEM C T1 728 С REDUCT RATIO OF TI TU NATURAL PERIOD CURRESPUNDING TO SHCH 728 YIELDING STIFFNESS SHCH 729 С С С CRACKING STRENGTH IN TERMS OF BASE SHEAR COEFFICIENT SHCH **X1STR** 730 VIELDING STRENGTH IN TERMS OF BASE SHEAR COEFFICIENT SHCH 731 X2STR SHCH 732 С DAMP DAMPING RATIU AVERAGE OF MAXIMUM ACCELERATION IN TERMS OF GRAVITY SHCH C AMAX 733 C C C ID NUMBER OF F1 INCREASED IN GEOMETRICAL RATIO SHCH 734 (SQRT(2.0)) SHCH 735 SHCH 736 SHCH 737 С \* \* \* \* \* \* \* \* \* \* \* \* \* SHCH C 738 С EARTHQUAKE ACCELEROGRAM SHCH 739 ZZ . C MJSKE NUMBER OF DATA OF EARTHQUAKE ACCELERUGRAM SHCH 740

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<b>c</b>	TH	TIME INCREM	ENT				SHCH	. 7
č	7 M A X	MAXIMUM ACCI	ELERATION				SHCH	ī
. C	2080						SHCH	7
č	81	STIFFNESS O	F EACH REGIO	N	,		SHCH	7
- č	xi(1)	CRACKING DI	SPLACEMENT				SHCH	2
č	X1(2)	YIELDING DI	SPLACEMENT				SHCH	ī
č		-					SHCH	1
č	* * * * * * *	* * * * * * *	* * * * * *	* * * * * * * *	* * * * * * * *		SHCH	ī
č							SHCH	
C	IF LAST CARD	) IS #STUP#tCO	LUMN 1-41, 51	UBROUTINE RETU	IRNS TO MAIN.		SHCH	
С		•			•		SHCH	
C	* * * * * *	* * * * * * *	* * * * * *	* * * * * * *	******		SHCH	
C							SHCH	
	DIMENSION NA	ME1(8),B1(3),	X1(2),ZZ(MJS)	KE)			SHCH	
	DATA KAERE/4	HS TUP/			4		SHCH	
1000	READ 100, NA	ME1					SHCH	
	IF (NAMEL(1)	-EQ-KAERE) GU	10 9999				SHCH	
	READ 102, TH	L+XT21K+X521K+	KEDUCI,DAMP,	AMAXIIU			SHCH	
		)					SHCH	
	11KK=11-1						SHCH	
	17#17#26KI14	44461.4444.415	TP YOSTP PED	UCT. DANP		•	SHCH	
	PRINI LUTE (	14761147747713 2 14150	IN INCOINTALD	UCITURINE			SHCH	
	AN-UARF +117.	185/T1}##2					SHCH	
	A1(2)=25000	T#R1(1)					SHCH	
·	BX=980.+(X2	STR-XISTR)		*			SHCH	
	X1(11=980.+)	(1STR/B1(1)					SHCH	
	X1(2)=980.+)	(2STR/B1(2)		1			SHCH	
	81(2)=8X/(X)	(2) - X1(1))					SHCH	
	81(3)=0.0014	81(2)					SHCH	
1.1.1	NSTEP=1						SHCH	
	IF(11.GT.2)	NSTEP=2					SHCH	
	DELTAT=TH*FL	OAT(NSTEP)					SHCH	
	PRINT 106, 1	T1,DELTAT,X1					SHCH	
<i>'</i> .	A8=81(1)						SHCH	
	AR=B1(1)*RR						SHCH	
	LLL=1		4				SHCH	
<b>E</b> .	IOA=8	· · · · · ·					SHCH	
'n	IF(11-61-5)	FUA=4		÷			SHUN	
	1F(11.GT.7)	LUA#Z			• • *		SUCU	
	AZ=0.0 ~						SHCH	
							SHCH	
				· .	1		SHCH	
							SHCH	
			1				SHCH	
	DMIN=X1(2)						SHCH	
	D01=0.0						SHCH	
	D02=0.0						SHCH	
	DCE=X1(1)						SHCH	
	DC=X1(1)						SHCH	
	DY=X1(2)						SHCH	
	ALPH=1.0						SHCH	
	K2=1						SHCH	
	GG=IOA						SHCH	
	DT=DELTAT/G	6					SHCH	
C							SHCH	
C	RESPONSE AN	ALYSIS					SHCH	
							C 1 C 1 1	

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. SHCH 80İ Al=A2 SHCH 802 V1=V2 D1=D2 SHCH 803 SHCH 804 VV1=VV2 SHCH 805 K1 = K2IF(I.NE.1) GO TO 10 SHCH 806 ZZZZZZ=ZZ(1)SHCH 807 GO TO 15 SHCH 808 SHCH 809 10 III=I-NSTEP SHCH ZZZZZZ=ZZ(1)-ZZ(1))810 SHCH 15 CONTINUE 811 ZZZLZZ=980.+ZZZLZZ+AMAX/ZMAX SHCH 812 SHCH CALL RESP1 (ZZZZZZ, A2, AR, AB, A1, V1, D1, DELTAT, V2, D2, VV2, LLL) 813 SHCH 814 IF(1-1) 20,25,20 SHCH 20 CONTINUE 815 DE=D2-D01-D02 SHCH 816 С SHCH 817 SHCH JUDGE FOR CHANGE OF POSITION 818 С SHCH 819 С SHCH CALL KAZU(VV1, VV2, D2, DMAX, DMIN, DE, DCE, K1, K2, LLL, JJJ) 820 IF(LLL) 30,25,30 SHCH 821 SHCH 822 25 CONTINUE CALL AVOMAX(02,00MAX) SHCH 823 GO TO 2 SHCH 824 SHCH 30 ZZZZZZ=ZZZZZZ/GG 825 SHCH 826 С RESPONSE ANALYSIS FOR SUBDIVIDED INTERVAL SHCH 827 С SHCH 828 С SHCH 829 DO 3 IA=1,IOA SHCH 830 IF(IA-1) 40,45,40 40 CONTINUE SHCH 831 SHCH 832 A1 = A2SHCH 833 V1=V2 SHCH 834 D1 = D2SHCH VV1=VV2 835 SHCH K1=K2 836 SHCH 837 45 CONTINUE SHCH CALL RESP1 (ZZZZZZ, A2, AR, AB, A1, V1, D1, DT , V2, D2, VV2, LLL) 838 SHCH 839 LLL=0 SHCH DE=D2-001-002 840 C SHCH 841 Ċ JUDGE FOR CHANGE OF POSITION SHCH 842 č SHCH 843 CALL KAZJ(VV1, VV2, D2, DMAX, DMIN, DE, DCE, K1, K2, LLL, JJJ) SHCH 844 SHCH 845 IF(LLL) 50,55,50 С SHCH 846 C DETERMINATION OF STIFFNESS SHCH 847 ċ SHCH 848 50 CALL SHUBOO(BI, AB, LLL, JJJ, DMAX, DMIN, DO1, DO2, DCE, ALPH, DY, DC, D2) SHCH 849 SHCH 850 AR=AB\*RR CALL AVDMAX(D2,D0MAX) SHCH 851 SHCH 852 GO TO 3 SHCH 853 55 CONTINUE SHCH 854 CALL AVOMAX(D2,DOMAX) SHCH 855 **3 CONTINUE** SHCH 856 LLL=1 SMCH 2 CONTINUE 857 SHICH 858 DUCT=DUMAX/X1(2) SHCH 859 PRINT 108, DOMAX, DUCT SHCH 860 1 CONTINUE

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	GO TU 1000	SHCH	861
	LOO FORMAT(3A4)	SHCH	862
	102 FORMAT(6F8.0,14)	SHCH	863
	104 FORMAT (1H1,844//	SHCH	864
	1 35H AVERAGE OF MAXIMUM ACCELERATION = ,F6.3/	SHCH	865
·	2 35H CRACKING STREAGTH = ,Fo.3/	SHCH	866
	3 35H YIELDING STRENGTH = ,F6.3/	2HCH	801
•	4 35H KATUUUF K2 TU KI IKEUULITUNI $= 10.37$	SHCH	900 9600
	5 550 UAMPING RATIU - (F0+3//)	SHCH	870
	$\frac{100}{1} = \frac{100}{10} = 10$	SHCH	871
	2 25H TIME INCREMENT $\pm 58.3/$	SHCH	872
	3 25H CRACKING DISPLACEMENT = ,Fd.3,2X, 3HCM /	SHCH	873
	4 25H YIELDING DISPLACEMENT = ,F3.3,2X,3HCM //)	SHCH	874
	108 FORMAT (1H -/	SHCH	875
	1 24H MAXIMUM DISPLACEMENT = ,F10.3,2X,3HCM /	SHCH	876
•	2 24H DUCTILITY FACTOR NT = $(F10.3/7)$	SHCH	877
	9999 RETURN	SHCH	878
	END	2HCH	813
	SUBPOUTINE FRIKO(7.77.N.NSTEP)	SHCH	880
	6	SHCH	881
· .	Č	SHCH	882
	C	SHCH	883
	C LINEAR INTERPOLATION FOR EARTHQUAKE MOTION	SHCH	884
•	<b>C</b>	SHCH	885
	C * * * * * * * * * * * * * * * * * * *	SHCH	886
	C	SHCH	881
	DIMENSION Z(I),ZZ(I)	SUCH	830
1 - A - A - A - A - A - A - A - A - A -	FNINSIEF Do 1 4-1 NSTED	SHCH	890
	277 ( )=7(1)=7(1)=7(1)=7(1)=7(1)=7(1)=7(1)=7(1	SHCH	891
		SHCH	892
	$DO = 2 I = 2 \cdot N$	SHCH	893
	II = NSTEP*(I-1)	SHCH	894
	DO 3 J=1,NSTEP	SHCH	895
	111=1-1	SHCH	9.39
	[]]]=[]]	SHCH	897
	ZZ(IIJJ)=(Z(I)-Z(III))*FLOAT(J)/FN+Z(III)	SHCH	898
	3 CONTINUE	2000 H	877
		SHEH	900
24.4		SHCH	902
	ENU	30000	30L
	SUBROUTINE RESP1(22,A2,A,B,A1,V1,D1,D1,V2,D2,VV2,KKK)	SHCH	903
•	C	SHCH	90%
	C ************************************	SHCH	905
		SHCH	906
	C LINEAK ACCELEKATION METHOD	SHCH	908
		SHCH	909
		SHCH	910
	IF (KKKEQ.0) GO TO 100	SHCH	911
	DT 2=DT/2.0	SHCH	912

IF(KKK.EQ.0) GO TO 100 DT2=DT/2.0

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w. 50 14 SHCH . 913 DT3=DT++2/2.0 SHCH 914 DT6=DT3/3.0 SHCH 915 S1=DT6\*B+DT2\*A+1 S2=DT3+B+DT+A SHCH 916 SHCH 917 \$3=DT\*8 SHCH 100 A2=-(S2\*A1+S3\*V1+ZZ)/S1 918 SHCH 919 VV2=DT\*V1+DT3\*A1+DTo\*A2 SHCH D2=D1+VV2 920 ¥2=¥1+DT\*A1+DT2\*A2 SHCH 921 SHCH 922 A2=A1+A2 SHCH 923 RETURN 924 SHCH END SHCH 925 SUBROUTINE SHUBBO(B,BK,K,J,DMAX,DMIN,DO1,DO2,DCE,ALFA,DY,DC,D2) С SHCH 926 С \* \* \* \* SHCH 927 c c SHCH 928 SHCH ~929 SELECTION OF STIFFNESS AT NEXT STEP C C SHCH 930 INPUT DATA SHCH 931 c c ORIGINAL STIFFNESS OF EACH REGION SHCH 932 B URIGINAL CRACKING DISPLACEMENT SHCH 933 DC. с С DY ORIGINAL VIELDING DISPLACEMENT SHCH 934 INDEX FOR CHANGE OF PUSITION K#O NON SHCH 935 κ C L. INDEX FUR CHANGE OF SIGN OF VELOCITY J#0 NÜN SHCH 936 Ĉ RELATIVE DISPLACEMENT SHCH 937 D2 SHCH С 938 SHCH 939 DUTPUT DATA С STIFFNESS AF NEXT STEP SHCH 940 C ΒK С DMAX YIELDING OR MAXIMUM DISPLACEMENT SHCH 941 č c NEGATIVE YIELDING OK MINIMUM DISPLACEMENT SHCH 942 DMIN CENTER OF FIRST REGION SHCH 943 001 SHCH CENTER OF SECOND REGION C 944 D02 ORIGINAL OR MODIFIED CRACKING DISPLACEMENT C DCE SHCH 945 Ċ ALFA RATIO OF REDUCTION IN RIGIDITY SHCH 946 SHCH 947 С SHCH 948 С \* \* \* \* SHCH С 949 DIMENSION B(3) SHCH 950 C SHCH 951 SHĊH 952 GO TO (1000,2000),J С SHCH 953 SHCH 954 1000 GO TO (1100,1200;1300),K SHCH 1100 BK=ALFA\*B(1) 955 GO TO 9000 SHCH 950 SHCH 957 1200 BK=ALFA+8(2) SHCH GO TO 9000 958 SHCH 959 1300 BK=ALFA\*B(3) SHCH 960 GO TO 9000 SHCH 961 С 2000 IF(K) 3000,3000,4000 SHCH 962 SHCH 963 С SHCH 964 3000 K=TABS(K) SHCH 965 GO TU (6000,3200,3300),K 3200 D01=D2-D02+DCE SHCH 966 SHCH 967 GO TO 6000 3300 DMIN=D2 SHCH 968

	Z1=DMAX-DMIN	SHCH	909
	ZZ=DY-DC	SHCH	970
	D01 = -71 = 72/(2.0 = DY)	SHCH	971
	GO TO 5000	сн	972
ċ		SHCH	973
¥0.00	GD TO (6000-4100-4200).K	SHUH	+14
A100	$0.01 \pm 0.2 \pm 0.02 \pm 0.000$	SHCH	975
4100	G0 T0 6000	SHCH	476
4200		SHCH	917
4200	71 = DMAX+DHIN	 NDrd	978
	72=0Y=0C	SHCH	979
	D01=73=72/(2.0+DV)	SHCH	980
<i>c</i>	B01-E1+EE/(210-51/	SHCH	941
6000	72-171-2 (*04)*313)	SHCH	982
5000	23-121-240+011+0131 74-0111±0(+0121±72	SHCH	984
		SHC H	201
	L ]= L + U + L ] / L + 		025
			201
	DUZ=(UMAX+UMIN//2.0		900
	DCE=21+0C/2.0/DY	SHUH	981
6000	BK=ALFA*B(1)	SHCH	988
9000	CONTINUE	SHUH	989
	RETURN	SHCH	990
	END	SHCH	991

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SHCH SUBROUTINE KAZU(V1,V2,X,XMAX,XMIN,XE,XCE,KL,K2,K,J) 992 SHCH 993 SHCH 994 SHCH 995 JUDGE FOR CHANGE OF POSITION AND DETERMINATION OF POSITION SHCH 996 SHCH 997 INPUT DATA SHCH 798 ٧1 INCREMENTAL DISPLACEMENT SHCH 999 ¥2 INCREMENTAL DISPLACEMENT OF LAST STEP SHCH 1000 SHCH 1001 RELATIVE DISPLACEMENT х SHCH 1002 XMAX YIELDING OR MAXIMUM DISPLACEMENT NEGATIVE VIELDING OR MINIMUM DISPLACEMENT XMIN SHCH 1003 RELATIVE DISPLACEMENT SHIFTED IN SKELETON CURVE SHCH 1004 XE ORIGINAL OR MODIFIED CRACKING DISPLACEMENT SHCH 1005 XCF SHCH 1006 INDEX FOR POSITION K1 OUTPUT DATA SHCH 1007 INDEX FOR PUSITION AT NEXT STEP Κ2 SHCH 1008 INDEX FOR CHANGE OF PUSITION K#J NUN SHCH 1009 ĸ INDEX FOR CHANGE UF DIRECTION SHCH 1010 1 SHCH 1011 SHCH 1012 SHCH 1013 SHCH 1014 IF(V1+V2) 2000,2000,100 SHCH 1015 SHCH 1016 100 J=1 SHCH 1017 IF(V2) 1000,110,110 110 IF(X-XMAX) 200,150,150 SHCH LU18 SHCH 1019 150 K2=3 SHCH 1020 GO TO 1600 SHCH 1021 200 IF(XE-XCE) 300,250,250 SHCH 1022 250 K2=2 GO TO 1600 SHCH 1023 300 IF (XE+XCE) 9999,350,350. SHCH 1024

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						14.,
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350	K2=1			•	SHCH	1025
	GO TO 1600				SHCH	1026
с					SHCH	1027
1000	IF (X-XMIN) 1150,1150,1200				SHCH	1028
1150	K2=3				SHCH	1029
	GO TO 1600			•	SHCH	1030
1200	IF(XE+XCE) 1250,1250,1300			٠.	SHCH	1031
1250	K2=2		•		SHCH	1032
	GO TO 1600				SHCH	1033
1300	IF(XE-XCE) 1350-1350-9999				SHCH	1034
1350	K2=1				SHCH	1035
	GO TO 1600				SHCH	1036
c					SHCH	1037
1600	IE(K2-K)) 1620.1630.1620				SHCH	1038
1620	K=K2				SHCH	1039
IVLU	GO TO 5000				SHCH	1040
1630	K=0		:		SHCH	1041
1000	CO TO 5000				SHCH	1042
с ·	00 10 5000				SHCH	1043
r					SHCH	1044
2000	1 - 2				SHCH	1045
2000	JE(V2) 3100.3100.2100				SHCH	1046
2100	TELY-YMINE 2150.2150 2200				SHCH	1047
2160	1F1A-AMINI 2190,2190,2200				SHCH	1048
2150					SHCH	1049
2200	10 10 3000 10 (VELVCE) 2250.2250.4000				SHCH	1050
2200	1F(AETAGE1 2230,2230,4000				SHCH	1051
2250					SHCH	1052
31.0.)	TELV-VMAYA 2200 4150 4150				SHCH	1053
3150	[F(A=AMAX7_3200;3130;3130;				SHCH	1054
2120					SHCH	1055
2200	GU TU 3000 Trive-YCEN (000 3050 3250				SHCH	1056
3200	IF(XE=XCE) 4000,5200,5200				SHCH	1057
3250	KZ=Z				SHCH	1058
(					SHCH	1059
4000					CHLM CHLM	1060
~ ~ ~ ~ ~	IF(K2-K1) 3500,5500,5500				SHCH	1061
5500					SHCH	1062
2522					3000	1062
3200	K=KZ				SHCH	1064
	K2=1				SHCH	1045
	GU TU 5000				SUCH	1065
6					3000 6000	1067
9999	WRITELO,80001	MICTAVEC	****//>			1068
8000	PURMAIL//JOAJZ8HFFFF LUGICAL	MISIAKES	++++//3		201611 6461	1060
5000					67L7	1070
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L c	DATA: EVANDI E				H DM2	1073

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c						 SHCH	1074
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0.6	2.5					 SHCH	1076
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2.0	2.5	1.606			· ·	SHCH	1080

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