SOIL-STRUCTURE INTERACTION METHODS SIM CODE

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MASTER

THE CITY UNIVERSITY OF NEW YORK
Under Contract to the
STRUCTURAL ANALYSIS GROUP
of
BROOKHAVEN NATIONAL LABORATORY
UPTON, NEW YORK 11973

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1.0 Introduction

Structure In Media (SIM) Code determines the response of a structure, embedded in a soil/rock media, to a specified dynamic disturbance in the media. The structure is modeled as a series of lumped mass, elastic beams which may be interconnected with elastic springs. The disturbance in the free field is specified in terms of an accelerogram, the scale of which may vary with depth. Soil/structure interaction is treated in two parts. The first determines the interaction forces developed at the base of the structure while the second evaluates the interaction forces developed along the side walls of the structure. Details of the model are discussed in Section 2.0 of this report.

Output from SIM Code consists of displacement time histories and/or response spectra at specified nodes within the structure. The shock spectra may be obtained as: a listing; an on line plot; a Calcomp plot; or any combination of the three.

The analytical basis for SIM Code is presented in Section 2.0, and the program organization including a description of subroutines is given in 3.0. Detailed control and input requirements for using the code are discussed in Section 4.0. Sample problems are contained in Section 5.0.

2.0 Analytical Basis for SIM Code

SIM Code treats the forced response of a partially buried structure to a specified disturbance traversing the location of the structure. A solution to this problem requires consideration of the structural model; soil/structure interaction; the free field disturbance; and numerical aspects of the solution. Each of these are discussed.

2.1 Structural Model

The structure is assumed to be elastic and is represented by its normal free-free modes of vibration. Forces acting on the structure are computed based upon an assumed interaction law.

Given a structure of (N) nodes, let the displacement vector be specified as,

$$\Delta = \left\{ \begin{array}{c} u_1 \\ \vdots \\ u_n \\ \hline \phi_1 \\ \vdots \\ \phi_n \end{array} \right\} \quad (1)$$

u_i = displacement (horizontal) of node i

ϕ_i = rotation of node i

The equations of motion may then be written as,

$$\begin{bmatrix} M & & \\ & J & \\ & & 0 \end{bmatrix} \begin{Bmatrix} \ddot{u} \\ \vdots \\ \ddot{\phi}_x \\ \vdots \\ \ddot{\phi}^0 \end{Bmatrix} + \begin{bmatrix} C_{11} & C_{12} & C_{13} \\ C_{21} & C_{22} & C_{23} \\ C_{31} & C_{32} & C_{33} \end{bmatrix} \begin{Bmatrix} \dot{u} \\ \vdots \\ \dot{\phi}_x \\ \vdots \\ \dot{\phi}^0 \end{Bmatrix} \quad (2)$$

$$+ \begin{bmatrix} K_{11} & K_{12} & K_{13} \\ K_{21} & K_{22} & K_{23} \\ K_{31} & K_{32} & K_{33} \end{bmatrix} \begin{Bmatrix} u \\ \vdots \\ \phi_x \\ \vdots \\ \phi^0 \end{Bmatrix} = \begin{Bmatrix} F \\ \vdots \\ R \\ \vdots \\ 0 \end{Bmatrix}$$

where,

M = mass matrix

J = rotary inertia (it is assumed that rotary inertia will be specified at only some nodes)

C = damping matrix

K = stiffness matrix

F = applied force vector

R = applied moment vector

ϕ_x = rotation of nodes with specified rotary inertia

ϕ^0 = rotation of nodes with no rotary inertia

2.1.1 Mass and Stiffness Matrices

The mass matrices (M, J) in Eq. (2) are taken as lumped masses so that M and J are diagonal matrices. The values of the lumped masses are input data to SIM Code.

The stiffness matrix (K) is formed for the entire structure considering the individual elements of the structure.

Two types of elements are considered: beams (including shear deformations); and concentrated shear/moment springs.

Beams

Under any set of loads the deflection of a beam may be determined as

$$\delta = \int_0^L \frac{Mm}{EI} dx + \int_0^L \frac{Vv}{AG} dx \quad (3)$$

where,

M = bending moment under applied loads

m = bending moment when unit load (moment) is applied at the point where deflection (rotation) is required

E = Young's Modulus

I = moment of inertia

L = span

V = shear under applied loads

v = shear when unit load (moment) is applied at point where displacement (rotation) is required

G = Shear Modulus

A = shear area (including shape factor)

Eq. (3) may be used to form the stiffness matrix of a beam between nodes (A) and (B) as,

$$\begin{Bmatrix} R_A \\ R_B \\ F_A \\ F_B \end{Bmatrix} = \begin{bmatrix} \beta & \alpha\beta & -\gamma L/2 & \gamma L/2 \\ \alpha\beta & \beta & -\gamma L/2 & \gamma L/2 \\ -\gamma L/2 & -\gamma L/2 & \gamma L/2 & -\gamma \\ \gamma L/s & \gamma L/2 & \gamma & \gamma \end{bmatrix} \begin{Bmatrix} \phi_A \\ \phi_B \\ u_A \\ u_B \end{Bmatrix} \quad (4)$$

$$\alpha = \left(\frac{L}{6EI} - \frac{1}{AGL} \right) / \left(\frac{L}{3EI} + \frac{1}{AGL} \right)$$

$$\beta = 1 / \left(\frac{L}{3EI} - \frac{\alpha L}{6EI} + \frac{1+\alpha}{AGL} \right)$$

$$\gamma = 1 / \left(\frac{L^3}{12EI} + \frac{L}{AG} \right)$$

SIM Code includes the capability of moment releases applied at either end of the beam. The corresponding element stiffness may be derived from Eq. (4) simply by setting (R_A) or (R_B) equal to zero and solving for the appropriate rotation.

Concentrated Springs

Concentrated springs may also connect nodes (A) and (B). The springs are taken to have a shear stiffness (S_L) a rotational stiffness (S_R) and a coupled stiffness (S_{LR}). The element stiffness may then be written as

$$\begin{Bmatrix} R_A \\ R_B \\ F_A \\ F_B \end{Bmatrix} = \begin{bmatrix} S_R & -S_R & -S_{LR} & -S_{LR} \\ -S_R & S_R & S_{LR} & S_{LR} \\ -S_{LR} & S_{LR} & S_L & -S_L \\ -S_{LR} & S_{LR} & -S_L & S_L \end{bmatrix} \begin{Bmatrix} \phi_A \\ \phi_B \\ u_A \\ u_B \end{Bmatrix} \quad (5)$$

Eqs. (4) and (5) may then be used to assemble the K matrix for the entire structure. Note that no boundary conditions have been applied so that the assembled stiffness matrix represents the "free-free" structure.

2.1.2 Structural Damping Matrix

The only restriction placed on the damping matrix C is that the eigenvectors are orthogonal with respect to C so that the equations uncouple. The following types of damping are included in SIM Code and may be used (rigid body damping is zero in all cases):

Modal Damping

Damping is input in terms of its modal values (β_j). Rather than read in (β_j) however the percent of critical damping in each mode is input. Critical damping is then

$$\beta_{cr} = 2\omega_j \quad (6)$$

Therefore if p_j is the ratio of critical damping desired, then

$$\beta_j = 2\omega_j p_j \quad (7)$$

Proportional Damping

Damping may be taken to be a linear combination of the (M) and (K) matrices and still satisfy the orthogonality condition. Let

$$[C] = \Omega [M] + \Theta [K] \quad (8)$$

Then

$$\beta_j = \Omega + \Theta \omega_j^2 \quad (9)$$

Rather than inputting (Ω) and (Θ) the ratio of critical damping desired (p) is input. The (Ω) and (Θ) parameters are then selected so that the damping ratios in the first two modes are (p) . This requires,

$$\begin{aligned} \Omega &= 2p (\omega_1 \omega_2^2 - \omega_2 \omega_1^2) / (\omega_2^2 - \omega_1^2) \\ \Theta &= 2p (\omega_2 - \omega_1) / (\omega_2^2 - \omega_1^2) \end{aligned} \quad (10)$$

Element Damping

Since the structure is often made of different materials with different damping characteristics, it is desirable to assign damping by elements or nodes. Let (p_i) be the percent of critical damping associated with the material at node point i . The damping matrix C is now assumed in the form:

$$[C] = [\Omega] \cdot [M] \quad (11)$$

From Eq. 2 the damping parameters become:

$$\beta_j = \frac{1}{\gamma_j} \sum_{i=1}^N \xi_{ji} \Omega_i M_i \xi_{ji} \quad (12)$$

where N is the total number of node points of the structural model. If all the nodes have the same damping ratio, then Eq. (7) applies. Solving equation (7) for Ω_i yields:

$$\Omega_i = 2p_i \omega_j \quad (13)$$

This definition of Ω_i is generalized to apply to the case where p_i are not constant, so that:

$$\beta_j = \frac{1}{\gamma_j} \sum_{i=1}^N \xi_{ji} 2p_i \omega_j M_i \xi_{ji} \quad (14)$$

An approximation inherent in this form of the analysis occurs since the modal orthogonality conditions are not satisfied by damping matrices of the form of (11) when the γ_i are not constant for all nodes.

2.2 Structure-Foundation Interaction Model

In determining the proper soil-structure model, two aspects of the interaction process will be considered, namely

1. equivalent stiffness and damping of the soil below the base of the structure, and
2. effects of depth of burial on the interaction

2.2.1 Base Interaction Parameters

The determination of the base interaction parameters is made by comparison with analytic solutions obtained for the steady state response of a uniform elastic half-space. These solutions were originally obtained by Bycroft (Reference 1) for circular foundations on the surface of the half-space. From these analyses, a series of studies were conducted from which equivalent base interaction springs and dampers were determined (References 2 to 8). In all cases, it was found that the base interaction constants were a function of the input steady state frequency. For a typical seismic input, however, the free-field motion consists of energy over a band of frequencies. This implies that the interaction parameters should then be a function of frequency of the input motion. Fortunately, for most of the parameters, this frequency dependence is not severe so that constant spring and dashpot parameters can be used.

The specific parameters used in the analysis are based upon the relationships listed below.

Horizontal Spring Constant:

$$K_x = (0.9) \frac{32 (1 - \mu)}{(7 - 8 \mu)} \rho V_s^2 a$$

Horizontal Dashpot Constant:

$$C_x = (0.57) \frac{32 (1 - \mu)}{(7 - 8 \mu)} \rho V_s a^2$$

Rocking Spring Constant:

(15)

$$K_{\theta} = (0.8) \frac{8}{3(1-\mu)} \rho V_s^2 a^3$$

Rocking Dashpot Constant:

$$C_{\theta} = (0.15) \frac{8}{3(1-\mu)} \rho V_s a^4$$

In Eq. (15), V_s is the shear wave velocity ($=\sqrt{G/\rho}$), G is the shear modulus of the soil, ρ is the soil mass density, μ is Poisson's ratio, and "a" is the base radius. The coefficients in parentheses in each equation are average values of the frequency dependent coefficients discussed above.

2.2.2 Depth of Burial Effects

In addition to the base stiffness effects listed above, the effects of depth of burial on the interaction parameters must be accounted for. To use the same philosophy as the previous analysis, that is, to represent the interaction process through a series of springs and dashpots, a different formulation technique must be used. In Reference 10, a detailed discussion of such an interaction model is presented. The loading applied to the structure is written as

$$\sigma_r = k (w_o - w_s) + s (\dot{w}_o - \dot{w}_s) \quad (16)$$

where

- σ_r = radial stress applied to the structure
- w_o = free-field radial displacement of the soil
- w_s = radial displacement of the structure
- $\dot{w}$ = corresponding radial velocities
- k = foundation interaction spring
- s = foundation interaction damper

This type of interaction law has been used previously for both static and dynamic problems (protective construction problems, culvert design), and was developed on the basis of both analytical and experimental studies on buried cylindrical structures. A comprehensive list of these references is presented in Reference (10).

To obtain the effective spring and dashpot parameters from Eq. (16), the following analysis must be performed. First for the ring response of the structure (no shell bending), the radial displacements can be written simply as

$$\begin{aligned} w_s &= x_s \cos \theta \\ w_o &= x_o \cos \theta \end{aligned} \quad (17)$$

where (x_s, x_o) are the centerline displacements of the structure and the free-field and θ is the angle around the periphery of the circular cross-section of the structure. The horizontal force component per foot of depth is then obtained from

$$F_H^1 = \int_0^{2\pi} \sigma_r a d\theta \quad (18)$$

where a is the radius of the structure. Substituting Eq. (16) into Eq. (18), the horizontal force per foot of depth is then

$$F_H^1 = K (x_o - x_s) + S (\dot{x}_o - \dot{x}_s) \quad (19)$$

where

$$\begin{aligned} K &= \pi a k \\ S &= \pi a s \end{aligned} \quad (20)$$

From Reference (10), the parameters k and s can be determined from the soil properties through

$$\begin{aligned} k &= F_K E_c / 2a \\ s &= F_S \rho V_c \end{aligned} \quad (21)$$

where E_c is the constrained modulus of the soil, ρ is the soil mass and V_c is the dilational wave speed of the soil. The parameters F_k and F_s are selected based on the experimental results of Reference (10) as 1/2.

For an elastic material the constrained modulus is simply

$$E_c = 2G(1-\mu) / (1-2\mu) \quad (22)$$

where G is the shear modulus and ν is Poisson's ratio. The dilatational wave speed is

$$V_c = \sqrt{\frac{E_c}{\rho}} \quad (23)$$

2.3 Free Field Motion

The free field motion is specified as an accelerogram describing the horizontal acceleration history of the free field at the site. The accelerations must be specified at a constant time increment and may have units of either (G 's) or (feet per second squared). A linear variation of acceleration is assumed between the specified data points so that at time (t) between the times (t_i) and (t_{i+1}) at which data is specified,

$$\begin{aligned} \ddot{W}(\tau) &= \ddot{W}_i + \frac{\tau}{\Delta t} \ddot{W}_{i+1} \\ \dot{W}(\tau) &= \ddot{W}_i \tau + \frac{\tau^2}{2\Delta t} \ddot{W}_{i+1} + \dot{W}_i \\ W(\tau) &= \frac{\ddot{W}_i \tau^2}{2} + \frac{\tau^3}{6\Delta t} \ddot{W}_{i+1} + \dot{W}_i \tau + W_i \end{aligned} \quad (24)$$

where,

$$\tau = t - t_i$$

$W, \dot{W}, \ddot{W}$ = displacement, velocity and acceleration of free field at time (t)

$$\Delta t = t_{i+1} - t_i$$

$\ddot{W}_i, \ddot{W}_{i+1}$ = specified acceleration at (t_i) and t_{i+1}

$W_i, \dot{W}_i$ = displacement and velocity at time (t_i) calculated from Eq. (24) from previous step ($t_{i-1} < t < t_i$).
Note in first step ($0 < t < t_i$) $W_0 = \dot{W}_0 = 0$

Displacements and velocities are required at all nodes where soil/structure interaction forces are to be calculated. A single accelerogram is specified and a factor given at each node for which interaction forces are generated. The displacement and velocity used to calculate the interaction forces at that node are the values computed for the accelerogram times the factor.

2.4 Method of Solution

Eqs. (2) are solved by first determining the modes of free vibration of the structure. Therefore solutions to the following eigenvalue problem are sought

$$\begin{bmatrix} M & 0 & 0 \\ 0 & J & 0 \\ 0 & 0 & 0 \end{bmatrix} \begin{Bmatrix} \ddot{u} \\ \vdots \\ \phi^* \\ \vdots \\ \phi^0 \end{Bmatrix} + \begin{bmatrix} K_{11} & K_{12} & K_{13} \\ K_{21} & K_{22} & K_{23} \\ K_{31} & K_{32} & K_{33} \end{bmatrix} \begin{Bmatrix} u \\ \vdots \\ \phi^* \\ \vdots \\ \phi^0 \end{Bmatrix} = \begin{Bmatrix} 0 \\ \vdots \\ 0 \\ \vdots \\ 0 \end{Bmatrix} \quad (25)$$

The last of Eqs. (25) may be solved for ϕ^0 as

$$\phi^0 = -k_{33}^{-1} (k_{31} u + k_{32} \phi^*) \quad (26)$$

Substituting Eq. (26) into the first two of Eqs. (25).

$$M^* \ddot{\Delta} + K^* \Delta = 0 \quad (27)$$

where,

$$M^* = \begin{bmatrix} M & 0 \\ 0 & J \end{bmatrix} \quad \Delta = \begin{Bmatrix} u \\ \phi^* \end{Bmatrix}$$

$$K^* = \begin{bmatrix} (K_{11} - K_{13} K_{33}^{-1} K_{31}) & (K_{12} - K_{13} K_{33}^{-1} K_{32}) \\ (K_{21} - K_{13} K_{33}^{-1} K_{31}) & (K_{22} - K_{23} K_{33}^{-1} K_{32}) \end{bmatrix}$$

Eq. (27) may be cast directly into eigenvalue form except that the system is unconstrained as yet (i.e., rigid body displacement and rotation modes of response are still included). So that a well set problem may be formulated, these rigid body displacements must be restrained. To this end take

$$\Delta = \begin{Bmatrix} u \\ \phi^* \end{Bmatrix} = u_R \begin{Bmatrix} \delta \\ 0 \end{Bmatrix} + \phi_R \begin{Bmatrix} Y \\ \delta \end{Bmatrix} + \begin{Bmatrix} \bar{u} \\ \bar{\phi}^* \end{Bmatrix} \quad (28)$$

where,

- $\bar{u}, \bar{\phi}^*$ = bending displacement vectors
- u_R = rigid body displacement of c.g.
- ϕ_R = rigid body rotation of c.g.
- δ = unit vector
- Y = vector of distance of node from c.g.

If the free modes of the structure are to be found, the sum of the inertial forces and sum of moments of inertial forces must both vanish to satisfy the free vibration equation of motion. Then

$$\begin{aligned} \Sigma \text{ Forces} &= 0 & \delta^1 M \ddot{u} &= 0 \\ \Sigma \text{ Moments} &= 0 & Y^1 M \ddot{u} + \delta^1 \ddot{\phi}^* &= 0 \end{aligned} \quad (29)$$

Using Eq. (28) the first of Eqs. (29) gives,

$$u_R = - \delta^1 \bar{M} \bar{u} / \delta^1 M \delta \quad (30)$$

and the second of Eqs. (29) gives,

$$\phi_R = - \frac{1}{(Y \bar{M} Y + \delta^1 J \delta)} \left[Y \bar{M} \bar{u} + \delta^1 J \bar{\phi}^* \right] \quad (31)$$

The eigenvalue problem of Eq. (27) may be solved if the rigid body displacement and rotation are constrained. Without any loss of generality these are taken to be zero. Therefore from Eqs. (30) and (31)

$$\begin{aligned} \delta^1 M \bar{u} &= 0 \\ Y^1 M \bar{u} + \delta^1 J \bar{\phi}^* &= 0 \end{aligned} \quad (32)$$

Eqs. (32) place two constraints on the displacements

$$\bar{\Delta} = \begin{Bmatrix} \bar{u} \\ \bar{\phi}^* \end{Bmatrix}$$

In SIM Code the displacement $\bar{u}_1$ and $\bar{u}_2$ are written in terms of the remaining displacements based on Eqs. (32). By expanding Eqs. (32) and solving for $\bar{u}_1$ and $\bar{u}_2$

$$\begin{Bmatrix} \bar{u}_1 \\ \bar{u}_2 \end{Bmatrix} = \begin{bmatrix} B_{11} & B_{12} \\ B_{21} & B_{22} \end{bmatrix} \begin{Bmatrix} \bar{u}^* \\ \bar{\phi}^* \end{Bmatrix} = \begin{bmatrix} b_1 & b_1 \end{bmatrix} \begin{Bmatrix} \bar{u}^* \\ \bar{\phi}^* \end{Bmatrix} \quad (33)$$

$$\bar{u}^* = \begin{Bmatrix} \bar{u}_3 \\ \vdots \\ \bar{u}_N \end{Bmatrix}$$

$$B_{11} = \frac{1}{D} (m_2 Y^{*1} M^0 - m_2 Y_2 \delta^1 M^0)$$

$$B_{12} = \frac{1}{D} (m_2 \delta^1 J)$$

$$B_{21} = \frac{1}{D} (m_1 Y_1 \delta^1 M^0 - m_1 Y^{*1} M^0)$$

$$B_{22} = - \frac{1}{D} (m_1 \delta^1 H)$$

$$Y^* = \begin{Bmatrix} y \\ \vdots \\ y_N \end{Bmatrix} \quad M^0 = \begin{bmatrix} m & & \\ & \ddots & \\ & & m_N \end{bmatrix}$$

Eq. (27) is now written in expanded form as (using Eq. (28))

$$u_R = \phi_R = 0)$$

$$\begin{bmatrix} M_E \\ M^0 \\ J \end{bmatrix} \begin{Bmatrix} \ddot{\bar{u}}_E \\ \vdots \\ \ddot{\bar{u}}^* \\ \vdots \\ \ddot{\bar{\phi}}^* \end{Bmatrix} + \begin{bmatrix} K_{11}^* & K_{12}^* & K_{13}^* \\ K_{21}^* & K_{22}^* & K_{23}^* \\ K_{31}^* & K_{32}^* & K_{33}^* \end{bmatrix} \begin{Bmatrix} \bar{u}_E \\ \vdots \\ \bar{u}^* \\ \vdots \\ \bar{\phi}^* \end{Bmatrix} = 0 \quad (34)$$

$$\bar{u}_E = \begin{Bmatrix} \bar{u}_1 \\ \bar{u}_2 \end{Bmatrix}$$

Substituting Eq. (33) into the last two of Eqs. (34),

$$\begin{bmatrix} M^0 \\ J \end{bmatrix} \begin{Bmatrix} \ddot{\bar{u}}^* \\ \ddot{\bar{\phi}}^* \end{Bmatrix} + \begin{bmatrix} (K_{22}^* + K_{21}^* b_1) & (K_{23}^* + K_{21}^* b_2) \\ (K_{32}^* + K_{31}^* b_1) & (K_{33}^* + K_{31}^* b_2) \end{bmatrix} \begin{Bmatrix} \bar{u}^* \\ \bar{\phi}^* \end{Bmatrix} = 0 \quad (35)$$

Eq. (35) is a well set eigenvalue problem which may be solved by standard methods. For free vibration

$$\begin{Bmatrix} \ddot{\bar{u}}^* \\ \ddot{\bar{\phi}}^* \end{Bmatrix} = -\omega^2 \begin{Bmatrix} \bar{u}^* \\ \bar{\phi}^* \end{Bmatrix} \quad (36)$$

Substituting Eq. (36) into Eq. (35)

$$\begin{bmatrix} M^0 \\ J \end{bmatrix}^{-1} \begin{bmatrix} K_{eg} \end{bmatrix} \begin{Bmatrix} \bar{u}^* \\ \bar{\phi}^* \end{Bmatrix} = \omega^2 \begin{Bmatrix} \bar{u}^* \\ \bar{\phi}^* \end{Bmatrix} \quad (37)$$

The power method is used to find the eigenvalues and eigenvectors of Eq. (37). Since the power method yields the mode associated with the highest eigenvalue

first the matrix on the L.H.S. of Eq. (37) is inverted and the eigenvalues ($1/\omega^2$) determined. The first mode determined then corresponds to the smallest value of (ω). The number of modes to be so extracted is then specified by the user. Let the eigenvalues and eigenvectors be given by

$$\begin{aligned} \omega_i, \{ \xi_i \} \quad i = 1, \dots, L \\ \xi_i^1 \hat{M} \xi_j = 0 \text{ if } i \neq j \\ = \gamma_i \text{ if } i = j \\ \xi_i^1 \hat{K} \xi_j = 0 \text{ if } i \neq j \\ = \omega_i^2 \gamma_i \text{ if } i = j \end{aligned} \quad (38)$$

where

$\hat{M}, \hat{K}$ = original mass and stiffness matrices in Eq. (2)

Finally the solution may be obtained by expanding the displacements in the modal vectors,

$$\begin{pmatrix} u \\ \dots \\ \phi^x \\ \dots \\ \phi^0 \end{pmatrix} = \sum_{i=1}^L \alpha_i \xi_i \quad (39)$$

where

α_i = participation factors to be evaluated

Eq. (39) is substituted into Eq. (2) and the resulting system of equations is premultiplied by (ξ_j^1) for values of $j = 1, \dots, L$. The resulting systems of equations using the orthogonality conditions of Eqs. (38) are,

$$\ddot{\alpha}_j + \beta_j \dot{\alpha}_j + \omega_j^2 \alpha_j = f_j, \quad j = 1, \dots, L \quad (40)$$

where

$$\begin{aligned} \beta_j &= \frac{1}{\gamma_j} \xi_j^1 C \xi_j \\ f_j &= \frac{1}{\gamma_j} \xi_j^1 \begin{Bmatrix} \cdot F \cdot \\ \cdot \dot{R} \cdot \\ \cdot \ddot{O} \cdot \end{Bmatrix} \end{aligned}$$

The forces (F) and (R) are computed based upon the interaction law as discussed in Section 2.2.

Eqs. (40) are integrated numerically using a 4th order Runge Kutta system to determine the participation factors. Once these are available the displacement may be found from Eq. (39). These equations are written in the form:

$$\begin{aligned}\dot{z}_j &= F_j = f_j - \omega_j^2 \alpha_j - \beta_j z_j \\ \dot{\alpha}_j &= z_j\end{aligned}\quad (41)$$

The basic 4th order Runge Kutta scheme is then

$$\begin{aligned}z_j(t+\Delta t) &= z_j(t) + \frac{1}{6} (k_j^1 + 2k_j^2 + 2k_j^3 + k_j^4) \\ \alpha_j(t+\Delta t) &= \alpha_j(t) + \frac{1}{6} (q_j^1 + 2q_j^2 + 2q_j^3 + q_j^4)\end{aligned}\quad (42)$$

The parameters (k_j) and (q_j) are computed in the following order:

$$\begin{aligned}q_j^1 &= \Delta t z_j(t) \\ k_j^1 &= \Delta t \left[f_j(t) - \omega_j^2 \alpha_j(t) - \beta_j z_j(t) \right] \\ q_j^2 &= \Delta t \left[z_j(t) + \frac{1}{2} k_j^1 \right] \\ k_j^2 &= \Delta t \left[f_j(t+\frac{\Delta t}{2}) - \omega_j^2 \left(\alpha_j(t) + \frac{1}{2} q_j^1 \right) - \beta_j \left(z_j(t) + \frac{1}{2} k_j^1 \right) \right] \\ q_j^3 &= \Delta t \left[z_j(t) + \frac{1}{2} k_j^2 \right] \\ k_j^3 &= \Delta t \left[f_j(t+\frac{\Delta t}{2}) - \omega_j^2 \left(\alpha_j(t) + \frac{1}{2} q_j^2 \right) - \beta_j \left(z_j(t) + \frac{1}{2} k_j^2 \right) \right] \\ q_j^4 &= \Delta t \left[z_j(t) + k_j^3 \right] \\ k_j^4 &= \Delta t \left[f_j(t+\Delta t) - \omega_j^2 \left(\alpha_j(t) + q_j^3 \right) - \beta_j \left(z_j(t) + k_j^3 \right) \right]\end{aligned}\quad (43)$$

3.0 Organization of SIM Code

A general flow chart showing the relationship of all subroutines is given in Fig. 1. The program is divided into two major segments. The first, controlled by SIM, determines the response of the lumped parameter model of the facility. The second, controlled by SPECTA, computes floor response spectra at selected points within the facility. Options are provided controlled by the parameter KRUN, to run both segments together or either one. For example SIM Code could be executed and the response stored on TAPE 8. This tape could then be mounted for future runs to calculate response spectra at selected locations.

PROGRAM LUMP

Figure 1.

4.0 Use of SIM Code

The control and input data required for use of SIM Code are given in this section of the report.

4.1 Control Data for SIM Code

There are several possible ways to use SIM Code and the required JCL for each one are listed below. The source update decks for SIM Code are stored on Tape K2427 at Brookhaven and each of the following calls for that tape. These decks may also be on the Permanent File (PF) SIM, ID=ZZGCAM.

(a) General Control Card : (AName), STMFZ, TP(k), T(l), P(m).

AName = any title you wish to use

k = number of tapes required to be handled by operator.

l = running time in octal seconds

m = priority of job

(b) Accounting Card : ACCOUNT (k, l)

k = any ID

l = any valid charge number

(c) Call in Program : FILE, OLDPL, RT=W, BT=I, MBL=5120.
STAGE, OLDPL, NT, PE, E, VSN=K2427, or
ATTACH (OLDPL, SIM, ID=ZZGCAM)
UPDATE (F)

(d) Call in free field data
if it is to be read in on
tape from permanent file
saved from SLAVE run: ATTACH(TAPE12, k, ID=l)

(omit if free field data on cards) k = same name given in SLAVE
l = same ID given in SLAVE

(e) For Microfiche copies of output: IDCARD(MIKE,\$Title of problem\$,Name,T129,PRFI)

(f) For Microfiche Calcomp: IDCARD(TAPE 99, Name,T129,\$Title of Problem\$,PLFI)

(f) Set up permanent file to save
SIM output for future SPECTRA
runs (omit if data not to be
saved) : REQUEST, TAPE10, *PF.

(g) Set up Calcomp Microfiche routines

: ATTACH(LIB 1, FR80LIB)
ATTACH, LIB2, CALCOMPLIB.
LIBRARY (LIB1, LIB2)

(h) Execute Program : FTN(I=COMPILE, L=0)
LGO.

(i) Save SIM Data for future SPECTRA
runs (omit if data not to be
saved) : CATALOG (TAPE10, k, ID=l, RP=30)

k = name of file to be used for calling
file for future use

(j) If Microfiche Copies of Output : REWIND(OUTPUT)
COPY(OUTPUT, MIKE)

(k) End of Record : 7₈₉

(l) End of Record : 7₈₉

(m) SIM Data : See Section 4.2

(n) End of Record : 7₈₉

(o) End of File : 6₇₈₉

If output from a previous SIM run is to be used to generate additional
spectra, the following changes are made:

- o Delete cards (d), (f), and (i)
- o Insert the following card after (c)

ATTACH(TAPE10, k, ID=l)

k, l are same parameters defined in (i)
above.

4.2 Input Data for SIM Code

The following card sets are required as input to SIM Code:

Set 1.0 KRUN (Format I5)

A control parameter which specifies whether both response and spectra computations are made and whether the response results are saved on TAPE 10.

KRUN=0; Make response and spectra computations.
No save tape.

KRUN=1; Make response computations only and save results in TAPE 10.

KRUN=2; Make spectra computations from prior response computation saved on TAPE 10.

(Card Sets 2.0 through 16.0 are not used if KRUN=2)

Set 2.0 ANAME (Format 20A4)

Problem Title

Set 3.0 NOD, MD, NBM, NEL, NROT, ITAPE (Format 14I5)

NOD = number of nodes (≤ 50)

MD = number of modes considered in solution
(≤ 20)

NBM = number of beam elements (no limit)

NEL = total number of elements = beams + springs
(no limit)

NROT = number of rotary inertias (no limit)

ITAPE= 0, no scratch tape for spectra analysis
written

= 1 write scratch tape for spectra analysis

Set 4.0 J, Y(J), W (Format I5,2E10.0) (NOD Cards)

J = Node number (≤ 50)

Y(J) = Elevation of node input (feet)
based on any datum.

W = Weight attached to Node J (Kips)

Set 5.0 J, W (Format I5, F10.0)(NROT Cards)

J = Node number

W = Rotary inertia attached to Node J (Kip feet
second²)

(Card Sets 6.0 and 7.0 are omitted if MD=0)

Set 6.0 K, KR, KS, KE, A, AS, XI, E, G (Format 4I5, 5E10.0) (NBM Cards)

K = Beam element number
KR = 0 no moment release at ends
= 1 release of end KS
= 2 release at end KE
KS = Starting node of beam
KE = End node of beam
A = Cross sectional area of beam (square feet)
AS = Shear area of beam (square feet)
XI = Moment of inertia (feet⁴)
E = Young's Modulus (Kips/feet²)
G = Shear Modulus (Kips/feet²)

Set 7.0 K, KS, KE, SL, SR, SLR (Format 3I5, 3E10.0) (NEL-NBM Cards)

K = Spring element number
KS = Start node for spring element
KE = End node for spring element
SL, SR, SLR = Spring stiffness (see Eq. 5)
(Kip Feet units)

Set 8.0 NAB, FK, FS (Format I5, 2E10.0)

NAB = Number of nodes at which depth of burial
interaction forces exist (≤ 20)
FK, FS = Interaction parameters - see Eq. (21)

Set 9.0 IA, SMOD, PCF, XNU, H, RADIUS, RATIO (Format I5, 6E10.0)(NAB Cards)

IA = Node number for depth of burial interaction
SMOD = Soil shear modulus at IA (Kips/feet²)
PCF = Soil density at IA (Kips/feet³)
XNU = Soil Poisson's Ratio
H = Length of structure contributing to inter-
action force at IA (feet)

RADIUS= Radius of structure at IA (feet)

RATIO = Free field displacement at the elevation
of node (IA) is the free field displacement
calculated in subroutine DIST times RATIO

Set 10.0 NB, DH, DR (Format I5, 2E10.0)

NB = Base interaction node number

DH = Percent of critical damping - horizontal

DR = Percent of critical damping - rocking

Note: if DH=DR=0 then Eqs 15 used to compute damping

Set 11.0 SMOB, RADB, PCFB, RATIOB, XNUB (Format 5E10.0)(No card if NB=0)

SMOB = Soil₂ shear modulus at base elevation (Kips/feet²)

RADB = Structural radius at base (feet)

PCFB = Soil density at base elevation (Kips/feet³)

RATIOB= Free field displacement at the base elevation
is the free field displacement calculated in
DIST times RATIOB

XNUB = Poisson's Ratio

(Note: Omit card sets 12.0 and 13.0 if MD=0)

Set 12.0 IDT (Format I5)

Type of Structural damping

IDT = 1 ; Proportional damping

= 2 ; Modal damping

= 3 ; Element damping

(See Section 2.1.2 for definition of damping)

Set 13.0 Damping values

if IDT = 1

13.1 XB (Format F10.0)

XB = p, ratio of critical damping

if IDT = 2

13.2 (BETA (I), I=1, MD) (Format 8F10.0) (MD Cards)

BETA(I) = Ratio of critical damping for mode I

if IDT = 3

13.3 (F(I), I=1, NOD) (Format 8 F10.0) (NOD Cards)

F(I) = Ratio of critical damping at node I

Set 14.0 ILOC, IDIM (format 2I5)

ILOC = 0 INPUT FROM CARDS

= 1 INPUT FROM TAPE 12 (SLAVE Code output)

IDIM = 0 Free Field Record in feet/second²

= 1 Free Field Record in G's

= 2 Free Field Record in inches/second²
(SLAVE output usually is in inches/second²)

Omit Set 15.0 and 16.0 if ILOC = 1. In this case Free field data is obtained from Tape 12 in the following format:

NDATA, TSTART, DADT, ITYP, (DD(I), I=1, NDATA)

Set 15.0 NDATA, DADT (Format I5, F10.0)

NDATA = Number of data points in input accelerogram

DADT = Time increment of data points on accelerogram (seconds)

Set 16.0 (DD(I), I=1, NDATA) (Format 8E9.0) (NDATA Cards)

8

DD(I) = Acceleration points on accelerogram.

(Note: time is not included; dimensions as specified by IDIM)

Set 17.0 TMAX, DT, NOUT, NOT, (NNT(I), I =1, NOT) (Format 2F10.0, 12I5)

TMAX = Maximum time for solution (seconds)

DT = Integration time step (seconds)

NOUT = Interval in number of time steps, between printed output

NOT = Number of nodes at which displacement histories are printed

NNT(I) = Node numbers at which displacement histories are printed

(Card sets 18.0 through 20.0 are not used if KRUN=1)

Set 18.0 NPOINT, NBETA, IPRINT, IDIM, IPLOT, IPUNCH (Format 14I5)

NPOINT = Number of nodes at which spectra are calculated

NBETA = Number of damping values used for spectra

IPRINT = 0 Do not print record for which spectra is calculated, otherwise print it.

IDIM = 0 input in inches/second²

= 1 input in G's

= 2 input in feet/second²

(Use 2 for standard SIM runs)

IPLOT = 0 Do not plot spectra on line, otherwise do

IPUNCH = 0 Do not print Calcomp plots of spectra, otherwise do

Set 19.0 (INODE(I), I=1, NPOINT) (Format 14I5) (NPOINT Cards)
14

INODE(I) = Node number at which spectra are to be calculated

Set 20.0 (XBETA(I), I=1, NBETA) (Format 8E10.0) (NBETA Cards)
8

XBETA(I) = Damping value for spectra I, ratio of critical

5.0 Sample Problems

Three sample problems are included. The structure considered is the FFTF reactor containment building and the input in the FFTF criteria pulse having a peak acceleration of 0.25 G's. The RCB and the stick model used for the first problem are shown on Fig. 5.1. Problems 2 and 3 are made with a rigid body model of the building. Problems 1 and 2 include the effects of interaction along the side wall (80 feet depth of burial) while the third problem assumes no side wall interaction. The input data are shown in Appendix A and the output in Appendices B through D.

Figure 5-1. FFTF Reactor Containment Building
Sample Problem #1

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9. T. Marrone, Interaction Formulae, Private Correspondence.
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APPENDIX A

INPUT TO SAMPLE PROBLEMS

```

YSIM,STMFZ,T140,P2.
ACCOUNT(CAM,373)
ATTACH(OLDPL,SINC,IB=CAM) — ~ FILE,TAPE,RT=W,BT=I,MBL=SIZE.
ATTACH(LIB1,FR&PLIR) STAGE,TAPE,RT,PE,E,V>N=K2427.
ATTACH,LIE2,CALCOMPLIB.
LIBRARY(LIB1,LIB2).
IDCARD(TAPE99,CAMILLER,T129,SSIM,SAMPLE.1$.PLFI)
IDCARD(MIKE,SSIM..SAMPLE.1$.CAMILLER,T129,PRFJ).
UPDATE(F)
FIN(I=COMPILE,L=0)
LGO.
REWIND(OUTPUT)
COPY(OUTPUT,MIKE)
R
R

```

02'
02'

SAMPLE PROBLEM 1 ...FFTF.FLEXIBLE STRUCT.. WALL INTERACTION			
41	5	39	42
1	470.	2800.	0
2	474.	5200.	1
3	485.75	13000.	
4	498.	16100.	
5	506.	13400.	
6	515.	8400.	
7	521.	6300.	
8	529.	12600.	
9	537.33	1000.	
10	547.	27000.	
11	500.	1800.	
12	510.	1200.	
13	520.	1200.	
14	530.	1200.	
15	535.	3300.	
16	515.	2300.	
17	525.	2400.	
18	587.75	1000.	
19	619.83	500.	
20	492.	200.	
21	508.	060.	
22	528.5	330.	
23	510.1	210.	
24	518.3	210.	
25	526.4	210.	
26	534.6	210.	
27	542.8	250.	
28	551.9	280.	
29	559.1	260.	
30	567.3	210.	
31	575.4	210.	
32	583.6	210.	
33	591.8	210.	
34	599.9	210.	
35	608.	190.	
36	616.	180.	
37	624.	200.	
38	632.	220.	
39	640.	240.	
40	648.	270.	
41	656.	250.	
NODE LOCATION WEIGHT			
1	0	1	2 4200. 3800. .145E 7 .5184E 6 .2376E 6
2	0	2	3 7300. 4320. .5157E 7 .5184E 6 .2376E 6
3	0	3	4 5639. 2880. .8648E 7 .5184E 6 .2376E 6
4	0	4	5 5900. 2420. .9114E 7 .5184E 6 .2376E 6

5	0	5	6	2400.	1030.	.3181E 7	.5184E 6	.2376E 6
6	0	6	7	2328.	1030.	.3181E 7	.5184E 6	.2376E 6
7	0	7	8	2328.	1030.	.3181E 7	.5184E 6	.2376E 6
8	0	8	9	2420.	1040.	.3663E 7	.5184E 6	.2376E 6
9	0	9	10	3260.	1360.	.3924E 7	.5184E 6	.2376E 6
10	0	3	11	640.	360.	.1222E 6	.8640E 6	.3686E 6
11	0	11	12	500.	260.	.1015E 6	.8640E 6	.3686E 6
12	0	12	13	500.	260.	.1015E 6	.8640E 6	.3686E 6
13	0	13	14	500.	260.	.1015E 6	.8640E 6	.3686E 6
14	0	14	15	790.	490.	.1415E 6	.8640E 6	.3686E 6
15	0	15	9	790.	490.	.1415E 6	.8640E 6	.3686E 6
16	0	5	16	1600.	830.	.3889E 7	.5184E 6	.2376E 6
17	0	16	17	1600.	830.	.3889E 7	.5184E 6	.2376E 6
18	0	20	21	14.7	7.4	.7650E 3	.4176E 7	.1570E 7
19	0	21	22	12.7	6.4	.6650E 3	.4176E 7	.1570E 7
20	0	22	15	12.7	6.4	.6650E 3	.4176E 7	.1570E 7
21	0	5	23	24.4	12.2	.1110E 6	.3960E 7	.1520E 7
22	0	23	24	24.4	12.2	.1110E 6	.3960E 7	.1520E 7
23	0	24	25	24.4	12.2	.1110E 6	.3960E 7	.1520E 7
24	0	25	26	24.4	12.2	.1110E 6	.3960E 7	.1520E 7
25	0	26	27	24.4	12.2	.1110E 6	.3960E 7	.1520E 7
26	0	27	28	24.4	12.2	.1110E 6	.3960E 7	.1520E 7
27	0	28	29	24.4	12.2	.1110E 6	.3960E 7	.1520E 7
28	0	29	30	24.4	12.2	.1110E 6	.3960E 7	.1520E 7
29	0	30	31	24.4	12.2	.1110E 6	.3960E 7	.1520E 7
30	0	31	32	24.4	12.2	.1110E 6	.3960E 7	.1520E 7
31	0	32	33	24.4	12.2	.1110E 6	.3960E 7	.1520E 7
32	0	33	34	24.4	12.2	.1110E 6	.3960E 7	.1520E 7
33	0	34	35	24.4	12.2	.1110E 6	.3960E 7	.1520E 7
34	0	35	36	17.6	8.8	.6080E 5	.3960E 7	.1520E 7
35	0	36	37	17.2	8.6	.7400E 5	.3960E 7	.1520E 7
36	0	37	38	16.2	8.1	.6260E 5	.3960E 7	.1520E 7
37	0	38	39	14.8	7.4	.4670E 5	.3960E 7	.1520E 7
38	0	39	40	12.4	6.2	.2890E 5	.3960E 7	.1520E 7
39	0	40	41	8.8	4.4	.9740E 4	.3960E 7	.1520E 7
1	10	18	5000E 5	.8400E 7				
2	18	19	.1600E 4	.4500E 7				
3	15	22		.3510E 9				

BEAM
DATA

SPRING DATA

10	.5	.5						
1	11560.	.130	.35	14.5	170.	1.		
2	11560.	.130	.35	7.88	170.	1.		
3	11560.	.130	.35	12.0	170.	1.		
4	11560.	.130	.35	10.1	170.	1.		
5	11560.	.130	.35	8.5	170.	1.		
6	11560.	.130	.35	7.5	170.	1.		
7	11560.	.130	.35	7.00	170.	1.		
8	11560.	.130	.35	8.17	170.	1.		
9	11560.	.130	.35	9.01	170.	1.		
10	11560.	.130	.35	7.84	170.	1.		

SIDE WALL
INTERACTION
DATA

1	11560.	170.	.130	1.	.35			
1								
.02								
15.	.002	200	1	2				
5	1	0	2	1	1			
1	15	19	22	41				

BASE INTERACTION

STRUCT. DAMPING

TIME INTERACTION*

SHOCK SPECTRA DATA

2. R. 02

* INSERT FREE FIELD PULSE HERE

SAMPLE PROBLEM 2 ...FFTF....RIGID STRUCT.. WALL INTERACTION					
14	0	13	13	0	1
1	470.		2800.		
2	474.		8200.		
3	485.75		13000.		
4	498.		18100.		
5	506.		14890.		
6	515.		11530.		
7	521.		10130.		
8	529.		14360.		
9	537.33		4530.		
10	547.		27230.		
11	574.25		1215.		
12	601.5		1465.		
13	628.75		965.		
14	656.		715.		
1	8	9	13	14	

NEW NODE DATA

NEW LOCATION FOR SPECTRA

OTHER DATA SAME AS #1 EXCEPT

BEAM, SPRING & STRUCT DAMPING DATA OMITTED

DATA FOR PROBLEM #3 SAME AS #2 EXCEPT

SIDE WALL INTERACTION DATA OMITTED

APPENDIX B

Sample Problem 1

Output

SAMPLE PROBLEM 1 ...FFTF.FLEXIBLE STRUCT.. WALL INTERACTION

NO. OF NODES • 41
 NO. OF MODES • 5
 NO. OF SHEAR BEAMS • 39
 NO. OF ELEMENTS • 42
 NO. OF INERTIAS • 0
 TAPE COUNTER • 1

NODE AND MASS DATA			
NODE	LOCATION	WEIGHT	MASS
1	470.000	2300.000	86.957
2	474.000	8200.000	254.658
3	485.750	13000.000	403.727
4	493.000	16100.000	500.000
5	505.000	13400.000	416.149
6	515.000	8400.000	260.870
7	521.000	6300.000	195.652
8	529.000	12600.000	391.304
9	537.330	1000.000	31.056
10	547.000	27000.000	839.509
11	500.000	1800.000	55.901
12	510.000	1200.000	37.267
13	520.000	1200.000	37.267
14	530.000	1200.000	37.267
15	535.000	3300.000	102.484
16	515.000	2300.000	71.429
17	525.000	2400.000	74.534
18	587.750	1000.000	31.056
19	619.830	500.000	15.528
20	492.000	200.000	6.211
21	508.000	660.000	20.497
22	528.500	330.000	10.248
23	510.100	210.000	6.522
24	518.300	210.000	6.522
25	526.400	210.000	6.522
26	534.600	210.000	6.522
27	542.800	260.000	8.075
28	551.900	280.000	8.696
29	559.100	260.000	8.075
30	567.300	210.000	6.522
31	575.400	210.000	6.522
32	583.600	210.000	6.522
33	591.800	210.000	6.522
34	599.900	210.000	6.522
35	608.000	190.000	5.901
36	616.000	180.000	5.590
37	624.000	200.000	6.211
38	632.000	220.000	6.832
39	640.000	240.000	7.453
40	648.000	270.000	8.385
41	656.000	250.000	7.764

BEAM DATA									
BEAM NO	MOMENT RELEASE	START NODE	END NODE	AREA (SQ.FT)	SHEAR AREA (SQ.FT)	MOMENT OF INERTIA (FT**4)	YOUNGS MODULUS (KSF)	SHEAR MODULUS (KSF)	LENGTH (FT)
1	0	1	2	4200.00	3800.00	.1450E+07	.5184E+06	.2376E+06	4
2	0	2	3	7300.00	4320.00	.5157E+07	.5184E+06	.2376E+06	11
3	0	3	4	5639.00	2880.00	.8648E+07	.5184E+06	.2376E+06	12
4	0	4	5	5900.00	2420.00	.9114E+07	.5184E+06	.2376E+06	8
5	0	5	6	2460.00	1030.00	.3181E+07	.5184E+06	.2376E+06	9
6	0	6	7	2328.00	1030.00	.3181E+07	.5184E+06	.2376E+06	6
7	0	7	8	2328.00	1030.00	.3181E+07	.5184E+06	.2376E+06	8
8	0	8	9	2420.00	1040.00	.3663E+07	.5184E+06	.2376E+06	8

9	0	9	10	3260.00	1350.00	.3924E+07	.5184E+06	.2370E+06	9.67
10	0	3	11	640.00	330.00	.1222E+06	.6340E+05	.3500E+06	14.25
11	0	11	12	500.00	260.00	.1015E+06	.6340E+05	.3500E+06	10.00
12	0	12	13	500.00	260.00	.1015E+06	.6340E+05	.3500E+06	10.00
13	0	13	14	500.00	260.00	.1015E+06	.6340E+05	.3500E+06	10.00
14	0	14	15	790.00	490.00	.1415E+06	.8540E+05	.3500E+06	5.00
15	0	15	9	790.00	490.00	.1415E+06	.8540E+05	.3500E+06	2.33
16	0	5	16	1600.00	830.00	.3898E+07	.5184E+06	.2376E+06	9.00
17	0	16	17	1600.00	830.00	.3898E+07	.5184E+06	.2370E+06	10.00
18	0	20	21	14.70	7.40	.7650E+03	.4176E+07	.1570E+07	16.00
19	0	21	22	12.70	6.40	.6550E+03	.4176E+07	.1570E+07	20.50
20	0	22	15	12.70	6.40	.6550E+03	.4176E+07	.1570E+07	6.50
21	0	5	23	24.40	12.20	.1110E+06	.3950E+07	.1520E+07	4.10
22	0	23	24	24.40	12.20	.1110E+06	.3950E+07	.1520E+07	8.20
23	0	24	25	24.40	12.20	.1110E+06	.3950E+07	.1520E+07	8.10
24	0	25	26	24.40	12.20	.1110E+06	.3950E+07	.1520E+07	8.20
25	0	26	27	24.40	12.20	.1110E+06	.3950E+07	.1520E+07	8.20
26	0	27	28	24.40	12.20	.1110E+06	.3950E+07	.1520E+07	9.10
27	0	28	29	24.40	12.20	.1110E+06	.3950E+07	.1520E+07	7.20
28	0	29	30	24.40	12.20	.1110E+06	.3950E+07	.1520E+07	8.20
29	0	30	31	24.40	12.20	.1110E+06	.3950E+07	.1520E+07	8.10
30	0	31	32	24.40	12.20	.1110E+06	.3950E+07	.1520E+07	8.20
31	0	32	33	24.40	12.20	.1110E+06	.3950E+07	.1520E+07	8.20
32	0	33	34	24.40	12.20	.1110E+06	.3950E+07	.1520E+07	8.10
33	0	34	35	24.40	12.20	.1110E+06	.3950E+07	.1520E+07	8.10
34	0	35	36	17.60	8.80	.6080E+05	.3950E+07	.1520E+07	8.00
35	0	36	37	17.20	8.60	.7400E+05	.3950E+07	.1520E+07	8.00
36	0	37	38	16.20	8.10	.6260E+05	.3950E+07	.1520E+07	8.00
37	0	38	39	14.80	7.40	.4670E+05	.3950E+07	.1520E+07	8.00
38	0	39	40	12.40	6.20	.2690E+05	.3950E+07	.1520E+07	8.00
39	0	40	41	8.80	4.40	.9740E+04	.3950E+07	.1520E+07	8.00

SPRING ELEMENT DATA

NUMBER OF SPRINGS=

3

SPRING ELEMENT NO. = 1
START NODE = 10 END NODE = 18
LATERAL STIFFNESS = 5.00000E+04
ROTAT. STIFFNESS = 8.40000E+06
COUPLED STIFFNESS = -0.
BEAM LENGTH = 4.07500E+01

SPRING ELEMENT NO. = 2
START NODE = 18 END NODE = 19
LATERAL STIFFNESS = 1.60000E+03
ROTAT. STIFFNESS = 4.56000E+06
COUPLED STIFFNESS = -0.
BEAM LENGTH = 3.20800E+01

SPRING ELEMENT NO. = 3
START NODE = 15 END NODE = 22
LATERAL STIFFNESS = -0.
ROTAT. STIFFNESS = 3.51000E+08
COUPLED STIFFNESS = -0.
BEAM LENGTH = 6.50000E+00

MODE 1 FREQUENCY = .16062E+01 CPS

MODE SHAPE
DISPLACEMENT/ROTATION

.20553E-01	.18556E-01	.12428E-01	.55322E-02	.17648E-02	-.29376E-02
-.61543E-02	-.10373E-01	-.14752E-01	-.19332E-01	.49284E-02	-.34688E-03
-.55235E-02	-.10897E-01	-.13528E-01	-.29340E-02	-.02170E-02	.12500E-01
.10000E+01	.91261E-02	.69752E-03	-.10115E-01	-.51156E-03	-.50704E-02
-.95793E-02	-.14149E-01	-.18721E-01	-.23794E-01	-.27804E-01	-.32355E-01
-.35835E-01	-.41413E-01	-.45952E-01	-.50424E-01	-.54634E-01	-.53327E-01
-.63756E-01	-.69170E-01	-.72555E-01	-.76940E-01	-.81282E-01	

.52376E-03	.52409E-03	.52458E-03	.52484E-03	.52498E-03	.52500E-03
.52512E-03	.52515E-03	.52517E-03	.52517E-03	.52522E-03	.52545E-03
.52553E-03	.52535E-03	.52524E-03	.52498E-03	.52492E-03	.52517E-03
.52517E-03	.52692E-03	.52676E-03	.52553E-03	.52552E-03	.52652E-03
.52742E-03	.52826E-03	.52901E-03	.52975E-03	.53026E-03	.53078E-03
.53122E-03	.53160E-03	.53192E-03	.53217E-03	.53237E-03	.53265E-03
.53281E-03	.53294E-03	.53304E-03	.53311E-03	.53317E-03	

MODE 2 FREQUENCY = .65050E+01CPS
MODE SHAPE
DISPLACEMENT/ROTATION

-.99582E-03	.78586E-03	-.53111E-03	-.21240E-02	-.31934E-02	-.30135E-02
-.28177E-02	-.24831E-02	-.20475E-02	-.16372E-02	-.12553E-02	-.14046E-02
-.15033E-02	-.16337E-02	-.19125E-02	-.43928E-02	-.55741E-02	.10000E+01
-.10555E+00	.30321E-02	.11642E-02	-.12211E-02	-.11988E-01	-.29924E-01
-.47933E-01	-.66523E-01	-.85145E-01	-.10568E+00	-.12161E+00	-.13930E+00
-.15635E+00	-.17307E+00	-.18913E+00	-.20423E+00	-.21847E+00	-.23495E+00
-.25045E+00	-.26497E+00	-.27828E+00	-.29025E+00	-.30013E+00	

.10196E-03	.10724E-03	.11595E-03	.12179E-03	.12529E-03	.11654E-03
.11166E-03	.10639E-03	.10298E-03	.10190E-03	.94585E-04	.85376E-04
.65393E-04	.94762E-04	.10004E-03	.12537E-03	.12537E-03	.10150E-03
.10190E-03	.11420E-03	.11280E-03	.10295E-03	.15999E-03	.22483E-03
.28345E-03	.33726E-03	.38550E-03	.43302E-03	.46605E-03	.49910E-03
.52720E-03	.55129E-03	.57128E-03	.58728E-03	.59990E-03	.61716E-03
.62735E-03	.63530E-03	.64143E-03	.64587E-03	.64913E-03	

MODE 3 FREQUENCY = .78721E+01CPS
MODE SHAPE
DISPLACEMENT/ROTATION

.12873E+00	.11842E+00	.82924E-01	.45272E-01	.19742E-01	-.20165E-01
-.46773E-01	-.81824E-01	-.11584E+00	-.15402E+00	.31093E-01	-.95527E-02
.50555E-01	-.90614E-01	-.10816E+00	-.67915E-02	-.35220E-01	.51916E+00
.87314E-02	.16635E-01	-.31595E-01	-.90483E-01	.50592E-01	.11400E+00
.17836E+00	.24462E+00	.31124E+00	.38431E+00	.44035E+00	.50163E+00
.55934E+00	.61583E+00	.66930E+00	.71611E+00	.75941E+00	.81426E+00
.65406E+00	.90876E+00	.94725E+00	.97898E+00	.10000E+01	

.29183E-02	.29216E-02	.29244E-02	.29165E-02	.29095E-02	.29790E-02
.30155E-02	.30526E-02	.30762E-02	.30826E-02	.31613E-02	.32522E-02
.32508E-02	.31600E-02	.31050E-02	.29099E-02	.29101E-02	.30826E-02
.30826E-02	.29936E-02	.29368E-02	.30596E-02	.27323E-02	.24016E-02
.21029E-02	.18290E-02	.15933E-02	.13427E-02	.11754E-02	.10082E-02
.66626E-03	.74481E-03	.64423E-03	.56381E-03	.50053E-03	.41409E-03
.36318E-03	.32359E-03	.29311E-03	.27111E-03	.25501E-03	

MODE 4 FREQUENCY = .12795E+02CPS
 MODE SHAPE
 DISPLACEMENT/ROTATION

-.62157E-02	-.64673E-02	-.71171E-02	-.78183E-02	-.79222E-02	-.63167E-02
-.50307E-02	-.31016E-02	-.11078E-02	-.26842E-02	-.53255E-02	-.30852E-02
-.97748E-03	.65230E-03	.57176E-03	-.89314E-02	-.99503E-02	.54741E-03
-.25013E-02	.10000E+01	.62641E+00	.10167E+00	-.76890E-02	-.76343E-02
-.71912E-02	-.65513E-02	-.57655E-02	-.46949E-02	-.37203E-02	-.25037E-02
-.12357E-02	.85393E-04	.14138E-02	.27031E-02	.39404E-02	.55809E-02
.71265E-02	.85580E-02	.92471E-02	.10931E-01	.11679E-01	
.63358E-04	.68412E-04	.68351E-04	.70575E-04	.71959E-04	.80085E-04
.87284E-04	.99509E-04	.11355E-03	.11393E-03	.37332E-04	.43911E-04
.79577E-04	.14490E-03	.17633E-03	.72354E-04	.72474E-04	.11393E-03
.11393E-03	.20433E-01	.18926E-01	.47826E-02	.69411E-04	.61509E-04
.54931E-04	.48713E-04	.42829E-04	.36800E-04	.32434E-04	.27925E-04
.23974E-04	.20490E-04	.17523E-04	.15083E-04	.13127E-01	.10392E-04
.87520E-05	.74542E-05	.64395E-05	.55972E-05	.51468E-05	

MODE 5 FREQUENCY = .18932E+02CPS
 MODE SHAPE
 DISPLACEMENT/ROTATION

.25200E-01	.23762E-01	.18522E-01	.10599E-01	.39055E-02	.42600E-02
.41240E-02	.35553E-02	.21450E-02	-.26406E-03	.15584E-01	.12657E-01
.90121E-02	.48834E-02	.30281E-02	.10702E-02	-.21397E-02	.69101E-02
.91766E-02	-.20085E-01	-.10890E-01	.18306E-02	-.66704E-01	-.26350E+00
-.42625E+00	-.57154E+00	-.69109E+00	-.78166E+00	-.81326E+00	-.80503E+00
-.76123E+00	-.68264E+00	-.57314E+00	-.43911E+00	-.28494E+00	-.66632E-01
.16202E+00	.39571E+00	.62309E+00	.83384E+00	.10000E+01	
.33085E-03	.33056E-03	.32726E-03	.32017E-03	.31141E-03	.30293E-03
.29941E-03	.29679E-03	.29586E-03	.29562E-03	.31339E-03	.31415E-03
.31324E-03	.30397E-03	.29731E-03	.31151E-03	.31155E-03	.29582E-03
.29552E-03	-.45643E-03	-.39128E-03	.13204E-03	.26206E-03	.11756E-03
-.82878E-04	-.33932E-03	-.64256E-03	-.10216E-02	-.13426E-02	-.17157E-02
-.20802E-02	-.24339E-02	-.27620E-02	-.30521E-02	-.33014E-02	-.36890E-02
-.39009E-02	-.40932E-02	-.42500E-02	-.43692E-02	-.44599E-02	

INTERACTION PARAMETERS
 UNITS KIPS-FEET-SECONDS
 K= .500*EC/A
 S= .500*RHOC

NODE NO. = 1

SMOD	=	.11560E+05	KCF	=	.13000E+00
XNU	=	.35000E+00	H	=	.14500E+02
RADIUS	=	.17000E+03	RATIO	=	.10000E+01
ESUBC	=	.50093E+05	RHOC	=	.14221E+02
XK	=	.11404E+07	S	=	.55036E+05

NODE NO. = 2

SMOD	=	.11550E+05	KCF	=	.13000E+00
XNU	=	.35000E+00	H	=	.76300E+01
RADIUS	=	.17000E+03	RATIO	=	.10000E+01
ESUBC	=	.50093E+05	RHOC	=	.14221E+02
XK	=	.61973E+06	S	=	.29909E+05

NODE NO. = 3

SMOD	=	.11550E+05	KCF	=	.13000E+00
XNU	=	.35000E+00	H	=	.12000E+02
RADIUS	=	.17000E+03	RATIO	=	.10000E+01
ESUBC	=	.50093E+05	RHOC	=	.14221E+02
XK	=	.94376E+06	S	=	.45547E+05

NODE NO. = 4

SMOD	=	.11550E+05	KCF	=	.13000E+00
XNU	=	.35000E+00	H	=	.10100E+02
RADIUS	=	.17000E+03	RATIO	=	.10000E+01
ESUBC	=	.50093E+05	RHOC	=	.14221E+02
XK	=	.79433E+06	S	=	.38335E+05

NODE NO. = 5

SMOD	=	.11550E+05	KCF	=	.13000E+00
XNU	=	.35000E+00	H	=	.85000E+01
RADIUS	=	.17000E+03	RATIO	=	.10000E+01
ESUBC	=	.50093E+05	RHOC	=	.14221E+02
XK	=	.66950E+06	S	=	.32263E+05

NODE NO. = 6

SMOD	=	.11550E+05	KCF	=	.13000E+00
XNU	=	.35000E+00	H	=	.75000E+01
RADIUS	=	.17000E+03	RATIO	=	.10000E+01
ESUBC	=	.50093E+05	RHOC	=	.14221E+02
XK	=	.58935E+06	S	=	.28467E+05

NODE NO. = 7

SMOD	=	.11550E+05	KCF	=	.13000E+00
XNU	=	.35000E+00	H	=	.70000E+01
RADIUS	=	.17000E+03	RATIO	=	.10000E+01
ESUBC	=	.50093E+05	RHOC	=	.14221E+02
XK	=	.55053E+06	S	=	.26500E+05

NODE NO. = 8

SMOD	=	.11550E+05	KCF	=	.13000E+00
XNU	=	.35000E+00	H	=	.81700E+01
RADIUS	=	.17000E+03	RATIO	=	.10000E+01
ESUBC	=	.50093E+05	RHOC	=	.14221E+02
XK	=	.64254E+06	S	=	.31010E+05

NODE NO. = 9

SMOD	=	.11550E+05	KCF	=	.13000E+00
XNU	=	.35000E+00	H	=	.90100E+01
RADIUS	=	.17000E+03	RATIO	=	.10000E+01

ESUBC	=	.50093E+05	RHOC	=	.14221E+02
XK	=	.70851E+06	S	=	.34192E+05

NODE NO. = 10

SMOD	=	.11560E+05	KCF	=	.13000E+00
XNU	=	.35000E+00	H	=	.78400E+01
RADIUS	=	.17000E+03	RATIO	=	.10000E+01
ESUBC	=	.50093E+05	RHOC	=	.14221E+02
XK	=	.61659E+06	S	=	.29759E+05

BASE INTERACTION NODE	=	1
PERCENT DAMP. HOR	=	-0.
PERCENT DAMP. ROT	=	-0.

INTERACTION PARAMETERS AT BASE

NODE NO. = 1

SMODB	=	.11560E+05	RADB	=	.17000E+03
KCFB	=	.13000E+00	RATIOB	=	.10000E+01
XKT	=	.18511E+12	XKH	=	.87592E+07
RHOC	=	.69316E+01	ST	=	.35113E+10
SH	=	.55733E+06	XNUB	=	.3500

SUMX	=	.16034E+08
SUMS	=	.90842E+06
FREQ	=	.10069E+02
CRITD	=	.50715E+06
GM(MD-1)	=	.40102E+04
PDAMP	=	.17912E+03

SUMXY	=	.19957E+12
SUMSY	=	.41611E+10
FREQ	=	.12633E+03
CRITD	=	.31597E+10
GM(MD)	=	.33571E+07
AIBASE	=	.12506E+08
YSTAR	=	.47764E+02
PDAMP	=	.13169E+03

MODAL DAMPING TYPE= 1

PROPORTIONAL DAMPING = .0200
 MODE GENERALIZED MASS DAMPING RATIO
 1 .16468E+02 .20000E-01
 2 .36004E+02 .20000E-01
 3 .99293E+02 .22683E-01
 4 .14495E+02 .33563E-01
 5 .51444E+02 .48113E-01
 6 .40102E+04 0.
 7 .33571E+07 0.
 FREE FIELD DATA FROM CARDS
 ACCELERATION DATA DT = .10000E-01

TMAX = .15000E+02
 DT = .20000E-02
 NOUT = 200
 NOT = 1
 NODES WHERE OUTPUT IS WANTED
 2

TIME	NODE	DISPL	VEL	ACC	ROT	ROTD	ROTDO
0.0000	2	0.	0.	0.	0.	0.	0.
.4000	2	.49568E-01	.29968E+00	.25751E+01	-.22344E-04	-.11636E-02	-.20737E-01
.8000	2	.26109E+00	.59749E+00	-.90642E+00	.14155E-04	.47695E-03	-.12034E-01
1.2000	2	.47791E+00	.53773E+00	.99035E+00	-.33996E-04	-.21727E-03	.26493E-01
1.6000	2	.57716E+00	.77504E-01	.23134E+01	.59209E-04	-.10637E-02	-.33852E-01
2.0000	2	.85997E+00	.49457E+00	-.83516E+01	.94388E-04	.28486E-02	-.66914E-01
2.4000	2	.95387E+00	-.45090E-01	-.21921E+01	-.15408E-04	-.33941E-02	-.66153E-01
2.8000	2	.11162E+01	.71147E+00	-.20800E+01	.14727E-03	.12541E-02	-.10158E-01
3.2000	2	.13800E+01	.38715E+00	-.80443E+00	-.30095E-04	.31696E-03	-.35219E-01
3.6000	2	.15275E+01	.68041E+00	.16580E+01	-.11882E-03	-.96491E-03	.57684E-01
4.0000	2	.18108E+01	.52300E+00	.90966E+00	.21571E-03	-.26575E-03	-.78719E-01
4.4000	2	.20095E+01	.14642E+00	.26950E+01	-.10018E-03	-.25452E-03	.68356E-02
4.8000	2	.21456E+01	.46378E+00	-.47440E+01	-.39645E-04	-.15444E-02	.10877E+00
5.2000	2	.22626E+01	.75268E+00	.22441E+00	-.72770E-04	.86678E-03	.31749E-02
5.6000	2	.26657E+01	.91699E+00	.55908E+00	.11191E-03	-.87327E-03	-.68999E-01
6.0000	2	.28742E+01	.35522E+00	-.13856E+01	-.72440E-04	.11482E-02	.44595E-01
6.4000	2	.29734E+01	-.17312E-01	-.33725E+00	.13722E-03	-.88530E-04	-.35457E-01
6.8000	2	.30868E+01	.82639E+00	.19414E+01	-.19683E-03	.52954E-03	.15551E-01
7.2000	2	.33826E+01	.85695E+00	.20491E+01	.10645E-03	-.51360E-03	-.65192E-01
7.6000	2	.35742E+01	.54442E+00	-.54979E+00	.42063E-04	.10607E-02	.39671E-01
8.0000							

8.4000	2	.38337E+01	.54669E-01	.32372E-02	-.67176E-04	-.68793E-03	-.10334E-01
8.8000	2	.39666E+01	.71720E+00	.63780E+00	.24783E-04	-.36897E-03	-.50759E-02
9.2000	2	.41577E+01	.46270E+00	-.82169E-01	-.36301E-04	.98291E-03	.33126E-01
9.6000	2	.43413E+01	.66175E+00	.20604E+01	-.41828E-04	-.17801E-02	-.47186E-02
10.0000	2	.46119E+01	.58023E+00	-.23933E+01	.40831E-04	.55462E-03	.29796E-01
10.4000	2	.48287E+01	.46569E+00	-.76940E+00	-.33575E-04	.81220E-03	-.11275E-01
10.8000	2	.49273E+01	.13593E+00	.17120E+01	.18443E-04	-.20120E-02	.35676E-01
11.2000	2	.50479E+01	.71636E+00	.27007E+01	-.85945E-04	-.20933E-03	.51550E-02
11.6000	2	.53450E+01	.49520E+00	-.14579E+00	.94473E-04	-.13890E-02	-.43976E-01
12.0000	2	.56157E+01	.60074E+00	-.27640E+01	-.66735E-06	.92743E-03	.27553E-02
12.4000	2	.56949E+01	.35101E+00	.28849E+01	-.83476E-04	-.26571E-02	.18314E-01
12.8000	2	.59138E+01	.53362E+00	-.13757E+01	.16031E-03	.11092E-02	-.29257E-01
13.2000	2	.60906E+01	.44998E+00	.25754E+01	-.18249E-03	.21913E-03	-.75827E-02
13.6000	2	.62757E+01	.49937E+00	-.49781E+00	.12484E-03	.66870E-04	.31627E-02
14.0000	2	.65166E+01	.72657E+00	-.20342E+01	-.60908E-04	.20940E-02	.44077E-01
14.4000	2	.67033E+01	.46339E+00	.30060E+01	-.10263E-03	-.31676E-02	.35133E-03
14.8000	2	.68593E+01	.28340E+00	-.17893E+01	.26149E-03	.14696E-02	-.48324E-01
	2	.70549E+01	.42038E+00	.41598E+00	-.18309E-03	.89418E-03	.63213E-02

NUMBER OF POINTS	•	5
NUMBER OF DAMPING VALUES	•	1
PRINT COUNTER	•	0
INPUT DIMENSIONS COUNTER	•	2
PLOT COUNTER	•	1
PRINT COUNTER	•	1
INPUT TAPE NO.	•	8

NODE NUMBERS

1	15	19	22	41
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DAMPING VALUES

2.000

CONTROL DATA READ OFF INPUT TAPE

ANAME = SAMPLE PROBLEM 1 ...FFTF.FLEXIBLE STRUCT.. WALL INTERACTION
 MD = 7
 NOD = 41
 DT1 = .20000E-02
 THAX = .15000E+02
 NRECD5= 7499
 NODE = 1

NO. OF INPUT RECORDS = 7499
 FINAL DISPLACEMENT (IN.) = .87386E+02
 FINAL VELOCITY (IN/SEC) = .54585E+01
 PEAK ACCELERATION (G.S) = .27485E+00

NO. OF RECORDS ADDED = 257
 FINAL NO. OF RECORDS = 7756
 FINAL VELOCITY (IN/SEC) = 0.
 FINAL DISPLACEMENT (IN.) = .89773E+02
 THAX. (DURATION, SECS) = .15510E+02

DAMPING RATIO= 2.00000E+00 PERCENT

FREQUENCY (CPS)	ACCELERATION (G.S)	VELOCITY (IPS)	DISPLACEMENT (IN)	MAX. TIME (SECS)
.50000	.22547	27.73173	8.82729	12.21800
.51171	.23950	28.78311	8.95236	12.13400
.52369	.24950	29.29993	8.90433	12.07000
.53595	.25740	29.53583	8.77099	12.00800
.54849	.26177	29.34979	8.51636	11.95400
.55133	.25426	27.85579	7.89795	11.68800
.57448	.26054	27.89115	7.72707	8.11600
.53792	.28747	30.06963	8.14004	8.07200
.60169	.30662	31.33901	8.28950	8.02600
.61578	.32117	32.07568	8.29037	8.74200
.63019	.33218	32.41606	8.18668	8.65800
.64495	.32969	31.43661	7.75770	8.59600
.66004	.31239	29.10557	7.01816	8.53600
.67550	.29461	26.82129	6.31941	12.01000
.69131	.32374	28.79399	6.63016	11.94400
.70750	.33083	28.75680	6.46900	12.53200
.72406	.35365	30.03737	6.60249	12.46000
.74101	.36342	30.16060	6.47792	12.39500
.75836	.34274	27.79399	5.83304	12.32000
.77611	.31548	24.99793	5.12625	15.47200
.79428	.32255	24.97316	5.00402	6.08000
.81269	.36631	27.71297	5.42598	6.03200
.83191	.39917	29.50769	5.64521	5.93000
.85138	.41755	30.16095	5.63819	5.92400
.87132	.41237	29.10502	5.31633	5.87600
.89172	.38147	26.30850	4.69559	5.81600
.91259	.41310	27.83763	4.85485	5.53600
.93396	.43997	28.97012	4.93678	4.9200
.95582	.46077	29.64588	4.93637	4.44400
.97820	.47290	29.73025	4.83717	4.41000
1.00110	.47696	29.29936	4.65809	4.84600
1.02454	.48361	29.02052	4.50938	4.81400
1.04852	.46747	27.41766	4.16172	4.78200
1.07307	.46735	26.78376	3.97250	6.02000

1.09319	.53574	30.00074	4.34784	5.96200
1.12390	.57937	31.71806	4.49157	5.91400
1.15022	.53550	31.30423	4.33156	5.87200
1.17714	.55289	28.82453	3.90532	5.83000
1.20470	.50479	25.76853	3.40432	6.97600
1.23291	.48371	24.12759	3.11461	6.93000
1.26177	.49461	24.10690	3.04074	11.25200
1.29131	.55752	26.55156	3.27250	12.30000
1.32154	.59094	27.03371	3.25571	12.61600
1.35248	.52587	23.91161	2.81333	12.55000
1.38414	.60064	26.68539	3.06852	6.85600
1.41655	.63304	27.48253	3.08777	6.82000
1.44971	.59766	25.35154	2.70429	7.12200
1.48355	.65460	27.13328	2.91065	13.63400
1.51839	.61697	25.06932	2.62773	14.14000
1.55393	.63044	24.94974	2.55537	2.17400
1.59031	.65107	25.17674	2.51953	2.16800
1.62754	.69343	26.31506	2.57331	14.65000
1.63555	.69257	25.57058	2.44330	5.65800
1.70464	.81508	29.40535	2.74545	5.30800
1.74455	.63701	31.26799	2.85257	5.26200
1.78539	.85727	29.52846	2.63225	5.22200
1.82719	.73739	24.81807	2.16174	2.35400
1.85997	.82261	27.05316	2.30252	12.05900
1.91375	.62394	26.47711	2.20194	12.00500
1.95855	.78323	24.74920	2.01122	2.34000
2.00440	.60037	24.55523	1.94993	2.33400
2.05133	.93936	28.16152	2.18495	5.19000
2.09935	1.01371	29.69525	2.25124	5.15200
2.14850	.94490	27.04637	2.00352	2.76200
2.19890	.95575	27.57019	1.99560	2.74800
2.25028	1.01674	27.78537	1.95524	2.73400
2.30296	1.03313	27.58324	1.90659	2.71800
2.35688	1.03157	26.91651	1.81762	2.70400
2.41205	1.01213	25.80524	1.70271	2.69300
2.46852	.99596	24.83586	1.60133	3.48200
2.52632	.99206	23.90515	1.50606	3.45800
2.58546	.95470	22.94622	1.41252	4.38900
2.64599	1.01375	23.56134	1.41720	4.35000
2.70794	.97515	22.14574	1.30158	2.63200
2.77133	1.03274	22.91702	1.31610	2.62200
2.83621	1.09193	23.67634	1.32861	2.61000
2.90261	1.13513	24.07115	1.31936	2.59300
2.97057	1.15639	23.93397	1.28264	2.58400
3.04011	1.15204	23.30423	1.22002	2.57200
3.11129	1.12691	22.27439	1.13943	2.55000
3.18412	1.08237	20.90439	1.04489	2.55000
3.25967	1.01151	19.08919	.93233	2.54000
3.33496	.90345	16.65996	.79506	2.53200
3.41304	.90456	16.29356	.76003	6.39400
3.49294	1.08040	19.02170	.85572	5.04400
3.57471	1.07565	18.50493	.82388	5.02200
3.65840	1.02911	17.29934	.75259	4.65200
3.74405	1.03241	16.95764	.72085	4.68200
3.83171	1.03810	16.66107	.69204	2.52600
3.92141	1.07462	16.85274	.68399	2.51600
4.01322	1.03487	15.85811	.62890	2.86800
4.10717	.95687	14.47706	.55099	14.56000
4.20333	.98928	14.48264	.54837	4.25400
4.30173	.97535	13.94365	.51589	4.23400
4.40244	.99068	13.83875	.50029	4.09400
4.50551	.93716	13.61062	.48079	4.07200
4.61099	1.07461	14.33227	.49470	2.82600
4.71894	1.08283	14.18969	.47857	2.81600
4.82942	1.09191	13.90429	.45822	2.69800
4.94248	1.09575	13.63404	.43904	2.69000

5.05319	1.07101	13.02129	.40971	2.60000
5.17651	1.02033	12.23162	.37607	2.67400
5.29780	1.02429	11.89004	.35720	2.65600
5.42183	1.01442	11.50512	.33776	2.65600
5.54876	.90760	10.05804	.28852	2.64600
5.67657	.93419	10.44174	.29265	5.75600
5.81161	1.04047	11.10030	.30413	5.74200
5.94767	1.00213	10.35181	.27727	5.73000
6.06591	.87324	8.62256	.23068	9.83200
6.22042	.89493	8.83481	.22572	5.71600
6.37526	.91970	8.87170	.22148	4.87400
6.52451	1.00232	9.44750	.23046	4.65200
6.67726	.84440	7.77693	.18537	4.65200
6.83358	.79792	7.18070	.16724	13.44000
6.93557	.76499	6.90275	.15709	5.70200
7.15729	.73245	6.29345	.13995	13.62800
7.32486	.77900	6.54030	.14211	1.96400
7.49534	.79776	6.54453	.13895	2.35000
7.67184	.76834	6.16139	.12762	4.65000
7.65145	.65057	6.66219	.13505	4.84400
8.03526	.76862	5.88260	.11652	4.03000
8.22338	.76935	5.75346	.11135	4.83900
8.41590	.70694	5.16594	.09769	4.83000
8.61293	.70256	5.01635	.09270	1.93000
8.81457	.72444	5.05426	.09126	4.83000
9.02093	.71890	4.90089	.08547	4.82200
9.23212	.67808	4.51684	.07787	4.81800
9.44826	.63077	4.10552	.06916	2.34200
9.66546	.69550	4.42973	.07291	4.81000
9.88533	.57428	3.56832	.05740	2.69000
10.12751	.53045	3.52467	.05539	2.33400
10.35461	.54843	3.25405	.04997	4.74400
10.60726	.54549	3.16255	.04745	4.68500
10.85559	.51186	2.89972	.04251	3.58600
11.10973	.49218	2.72444	.03903	4.73500
11.36993	.54550	2.55106	.04131	4.68200
11.63501	.51330	2.71265	.03711	4.62400
11.90643	.52146	2.69295	.03599	2.33200
12.18722	.51037	2.57534	.03363	2.32800
12.47254	.52947	2.61052	.03331	3.56400
12.76454	.46367	2.23390	.02785	2.32600
13.06338	.46847	2.20539	.02687	5.69000
13.35921	.48564	2.23849	.02665	2.32800
13.68220	.51660	2.32198	.02701	2.32600
14.00252	.51183	2.24791	.02555	2.32200
14.33034	.48106	2.06444	.02293	2.32000
14.66583	.46588	1.95355	.02120	4.61600
15.00918	.41582	1.70375	.01807	4.81000
15.36056	.45150	1.80762	.01873	2.32200
15.72018	.44714	1.74922	.01771	2.31800
16.08821	.43534	1.65411	.01646	2.31800
16.46485	.42297	1.57984	.01527	2.31800
16.85032	.42758	1.56052	.01474	2.31600
17.24481	.42624	1.52004	.01403	2.31600
17.64054	.41556	1.44003	.01306	2.31400
18.08171	.40579	1.38165	.01217	2.31400
18.48456	.40129	1.33508	.01150	2.31200
18.91731	.37844	1.23025	.01035	2.31000
19.36019	.35361	1.12322	.00923	2.31000
19.81344	.33727	1.04683	.00841	2.31000
20.27730	.31951	.96933	.00761	2.30800
20.75202	.30854	.91434	.00701	2.31000
21.23786	.30210	.87478	.00656	2.31000
21.73507	.29771	.84234	.00617	2.31200
22.24391	.29483	.81512	.00583	2.31200
22.76468	.29248	.79012	.00552	2.31200

23.29763	.29052	.76587	.00524	2.31400
23.84305	.28318	.74585	.00483	2.31400
24.40126	.28793	.72567	.00473	2.31400
24.97253	.28585	.70641	.00450	2.31400
25.55717	.28584	.68782	.00428	2.31400
26.15550	.28488	.66931	.00408	2.31400
26.76783	.28421	.65296	.00398	2.31600
27.39451	.28359	.63653	.00370	2.31600
28.03565	.29303	.62084	.00352	2.31600
28.69221	.28248	.60546	.00336	2.31600
29.35393	.28193	.59056	.00320	2.31600
30.05138	.28149	.57604	.00305	2.31600
30.75493	.28103	.56193	.00291	2.31600
31.47494	.28050	.54825	.00277	2.31600
32.21182	.28019	.53482	.00264	2.31600
32.95594	.27950	.52197	.00252	2.31600
33.73772	.27944	.50936	.00240	2.31600
34.52757	.27915	.49720	.00229	2.31600
35.33591	.27839	.48538	.00219	2.31800
35.16317	.27835	.47386	.00209	2.31800
37.00930	.27841	.46263	.00199	2.31800
37.87625	.27819	.45169	.00190	2.31800
38.76299	.27793	.44102	.00181	2.31800
39.67048	.27778	.43062	.00173	2.31800
40.59922	.27759	.42048	.00165	2.31800
41.54971	.27741	.41060	.00157	2.31800
42.52245	.27724	.40096	.00150	2.31800
43.51796	.27708	.39156	.00143	2.31800
44.53377	.27694	.38240	.00137	2.31800
45.57944	.27679	.37346	.00130	2.31800
46.64652	.27656	.36475	.00124	2.31800
47.73858	.27654	.35624	.00119	2.31800

CALCOMP SPECTRA PLOT READY
 TITLE ▪ SAMPLE PROBLEM 1 ...FFTF.FLEXIBLE STRUCT.. WALL INTERACTION
 NODE NO.▪ 1
 DAMPING ▪ 2.00000E+00 PERCENT
 PEAK G.S ▪ 1.15539E+00
 MAX SCALE▪ 1.30000E+01 G.S
 FIRSTY ▪ 0. G.S
 DELTA A ▪ 2.36364E-01 G.S/INCH
 FIRSTX ▪ 0.
 DELTA X ▪ 1.00000E+00
 IPOWER ▪ -1

SAMPLE PROBLEM 1 ... FFTF FLEXIBLE STRUCT... WALL INTERACTION
 NODE POINT= 1 EQUIPMENT DAMPING= 2.00000E-02

SAMPLE PROBLEM 1 ...FFTF.FLEXIBLE STRUCT.. WALL INTERACTION
 NODE POINT= 15 EQUIPMENT DAMPING= 2.00000E-02

SAMPLE PROBLEM 1 ...FFTF.FLEXIBLE STRUCT.. WALL INTERACTION
 NODE POINT= 19 EQUIPMENT DAMPING= 2.00000E-02

SAMPLE PROBLEM 1 ... FFTF FLEXIBLE STRUCT.. WALL INTERACTION
 NODE POINT= 22 EQUIPMENT DAMPING= 2.00000E-02

SAMPLE PROBLEM 1 ... FFTF FLEXIBLE STRUCT.. WALL INTERACTION
 NODE POINT= 41 EQUIPMENT DAMPING= 2.00000E-02

2.0 PERCENT DAMPING NODE = 41

APPENDIX C

Sample Problem 2

Output

SAMPLE PROBLEM 2 ...FFTF....RIGID STRUCT.. WALL INTERACTION

NO. OF NODES = 14
 NO. OF NODES = 0
 NO. OF SHEAR BEAMS = 13
 NO. OF ELEMENTS = 13
 NO. OF INERTIAS = 0
 TAPE COUNTER = 1

NODE AND MASS DATA			
NODE	LOCATION	WEIGHT	MASS
1	470.000	2800.000	85.957
2	474.000	8200.000	254.658
3	465.750	13000.000	403.727
4	438.000	18100.000	562.112
5	506.000	14890.000	462.422
6	515.000	11530.000	358.075
7	521.000	10130.000	314.596
8	529.000	14360.000	445.963
9	537.330	4530.000	140.683
10	547.000	27230.000	845.652
11	574.250	1215.000	37.733
12	601.500	1465.000	45.497
13	628.750	965.000	29.969
14	656.000	715.000	22.205

INTERACTION PARAMETERS
 UNITS KIPS-FEET-SECONDS
 K= .500*EC/A
 S= .500*RHOC

NODE NO. = 1

SMOD	=	.11560E+05	KCF	=	.13000E+00
XNU	=	.35000E+00	H	=	.14500E+02
RADIUS	=	.17000E+03	RATIO	=	.10000E+01
ESUBC	=	.50093E+05	RHOC	=	.14221E+02
XK	=	.11404E+07	S	=	.55036E+05

NODE NO. = 2

SMOD	=	.11560E+05	KCF	=	.13000E+00
XNU	=	.35000E+00	H	=	.78800E+01
RADIUS	=	.17000E+03	RATIO	=	.10000E+01
ESUBC	=	.50093E+05	RHOC	=	.14221E+02
XK	=	.61973E+06	S	=	.29909E+05

NODE NO. = 3

SMOD	=	.11560E+05	KCF	=	.13000E+00
XNU	=	.35000E+00	H	=	.12000E+02
RADIUS	=	.17000E+03	RATIO	=	.10000E+01
ESUBC	=	.50093E+05	RHOC	=	.14221E+02
XK	=	.94376E+06	S	=	.45547E+05

NODE NO. = 4

SMOD	=	.11560E+05	KCF	=	.13000E+00
XNU	=	.35000E+00	H	=	.10100E+02
RADIUS	=	.17000E+03	RATIO	=	.10000E+01

ESUBC	=	.50093E+05	RHOC	=	.14221E+02
XK	=	.79433E+06	S	=	.38336E+05

NODE NO. = 5

SMOD	=	.11560E+05	KCF	=	.13000E+00
XNU	=	.35000E+00	H	=	.85000E+01
RADIUS	=	.17000E+03	RATIO	=	.10000E+01
ESUBC	=	.50093E+05	RHOC	=	.14221E+02
XK	=	.66850E+06	S	=	.32263E+05

NODE NO. = 6

SMOD	=	.11560E+05	KCF	=	.13000E+00
XNU	=	.35000E+00	H	=	.75000E+01
RADIUS	=	.17000E+03	RATIO	=	.10000E+01
ESUBC	=	.50093E+05	RHOC	=	.14221E+02
XK	=	.58985E+06	S	=	.28467E+05

NODE NO. = 7

SMOD	=	.11560E+05	KCF	=	.13000E+00
XNU	=	.35000E+00	H	=	.70000E+01
RADIUS	=	.17000E+03	RATIO	=	.10000E+01
ESUBC	=	.50093E+05	RHOC	=	.14221E+02
XK	=	.55053E+06	S	=	.26569E+05

NODE NO. = 8

SMOD	=	.11560E+05	KCF	=	.13000E+00
XNU	=	.35000E+00	H	=	.81700E+01
RADIUS	=	.17000E+03	RATIO	=	.10000E+01
ESUBC	=	.50093E+05	RHOC	=	.14221E+02
XK	=	.64254E+06	S	=	.31010E+05

NODE NO. = 9

SMOD	=	.11560E+05	KCF	=	.13000E+00
XNU	=	.35000E+00	H	=	.90100E+01
RADIUS	=	.17000E+03	RATIO	=	.10000E+01
ESUBC	=	.50093E+05	RHOC	=	.14221E+02
XK	=	.70861E+06	S	=	.34199E+05

NODE NO. = 10

SMOD	=	.11560E+05	KCF	=	.13000E+00
XNU	=	.35000E+00	H	=	.78400E+01
RADIUS	=	.17000E+03	RATIO	=	.10000E+01
ESUBC	=	.50093E+05	RHOC	=	.14221E+02
XK	=	.61659E+06	S	=	.29758E+05

BASE INTERACTION NODE	=	1
PERCENT DAMP. HOR	=	-0.
PERCENT DAMP. ROT	=	-0.

INTERACTION PARAMETERS AT BASE

NODE NO. = 1

SMOOS = .11560E+05 RAD8 = .17000E+03
 KCF8 = .13000E+00 RATIO8 = .10000E+01
 XKT = .18611E+12 XKH = .87592E+07
 RHOC = .68316E+01 ST = .35113E+10
 SH = .55733E+06 XNUS = .3500

SUMK = .16034E+08
 SUMS = .90842E+06
 FREQ = .10069E+02
 CRITD = .50715E+06
 GM(MD-1) = .40102E+04
 POAMP = .17912E+03

SUMKY = .19957E+12
 SUMSY = .41611E+10
 FREQ = .12579E+03
 CRITD = .31730E+10
 GM(MD) = .34554E+07
 AIBASE = .12612E+08
 YSTAR = .47784E+02
 POAMP = .13114E+03

1 .40102E+04 0.
 2 .34554E+07 0.
 FREE FIELD DATA FROM CARDS
 ACCELERATION DATA DT = .10000E-01

THAX = .15000E+02
 DT = .20000E-02
 NOUT = 200
 NOT = 1
 NODES WHERE OUTPUT IS WANTED

TIME	NODE	DISPL	VEL	ACC	ROT	ROTD	ROTD0
0.0000	2	0.	0.	0.	0.	0.	0.
.4000	2	.49589E-01	.30028E+00	.25394E+01	-.17052E-04	-.46612E-03	.54602E-02
.8000	2	.26109E+00	.59786E+00	-.89409E+00	.45998E-05	.11574E-03	.21629E-02
1.2000	2	.47791E+00	.53771E+00	.10032E+01	-.19271E-04	-.27890E-03	.20395E-01
1.6000	2	.57717E+00	.77971E-01	.22700E+01	.46300E-05	-.48784E-03	-.12846E-01
2.0000	2	.85994E+00	.49583E+00	-.82988E+01	.94978E-04	.70133E-03	-.17072E-01
2.4000	2	.95390E+00	-.44167E-01	-.22676E+01	.88397E-04	-.44478E-03	-.38624E-01
2.8000	2	.11162E+01	.71083E+00	-.20686E+01	.49267E-05	.86052E-03	-.19486E-01
3.2000	2	.13800E+01	.38792E+00	-.83039E+00	.37269E-04	-.33591E-03	-.10537E-01
3.6000	2	.15275E+01	.67959E+00	.16755E+01	-.40908E-04	.20987E-04	.18392E-01
4.0000	2	.18108E+01	.52397E+00	.83311E+00	.36556E-04	-.50715E-03	-.25118E-01
4.4000							

4.8000	2	.20095E+01	.14635E+00	.26343E+01	.93993E-05	-.87169E-03	-.36452E-02
5.2000	2	.21457E+01	.46191E+00	-.47117E+01	-.64647E-05	.68878E-03	.39996E-01
5.6000	2	.22626E+01	.75270E+00	.24200E+00	-.33896E-04	.53803E-03	.51674E-02
6.0000	2	.26657E+01	.91830E+00	.49434E+00	.24820E-04	-.51352E-03	-.72568E-02
6.4000	2	.28741E+01	.35428E+00	-.13246E+01	.28818E-05	.42859E-03	-.60105E-02
6.8000	2	.29734E+01	-.17103E-01	-.34769E+00	.43407E-04	-.27322E-03	-.27366E-01
7.2000	2	.30868E+01	.82619E+00	.19472E+01	-.38733E-04	.24389E-03	.74666E-03
7.6000	2	.33826E+01	.85827E+00	.20511E+01	-.24920E-04	.48327E-04	-.56105E-02
8.0000	2	.36742E+01	.54387E+00	-.54514E+00	.19132E-05	-.20720E-03	.16512E-01
8.4000	2	.38337E+01	.54888E-01	-.22628E-01	.24014E-04	-.33584E-03	-.82171E-02
8.8000	2	.39686E+01	.71755E+00	.64692E+00	-.35350E-04	.19212E-03	.18683E-01
9.2000	2	.41577E+01	.46215E+00	-.47751E-01	-.16145E-04	.19791E-03	.77357E-02
9.6000	2	.43414E+01	.66203E+00	.20058E+01	-.39568E-04	-.14469E-03	.20703E-01
10.0000	2	.46119E+01	.57949E+00	-.23570E+01	.22052E-04	.22772E-03	-.10655E-02
10.4000	2	.48287E+01	.46640E+00	-.71437E+00	.51174E-05	-.49948E-04	.74860E-02
10.8000	2	.49273E+01	.13562E+00	.17070E+01	-.68966E-05	-.72888E-03	.20267E-01
11.2000	2	.50479E+01	.71642E+00	.26654E+01	-.49718E-04	.17046E-04	.13688E-01
11.6000	2	.53450E+01	.49578E+00	-.21341E+00	.27252E-04	-.33454E-03	-.88819E-02
12.0000	2	.56156E+01	.60042E+00	-.27433E+01	.30080E-04	.33056E-03	-.93475E-02
12.4000	2	.56949E+01	.35097E+00	.28632E+01	-.35039E-04	-.35446E-03	.14242E-01
12.8000	2	.59136E+01	.53417E+00	-.13872E+01	.10182E-04	.62284E-04	.60713E-02
13.2000	2	.60906E+01	.45011E+00	.25648E+01	.85880E-05	-.41131E-03	-.23150E-01
13.6000	2	.62757E+01	.49936E+00	-.42994E+00	-.20472E-04	.39316E-03	.78981E-02
14.0000	2	.65166E+01	.72532E+00	-.20233E+01	.54448E-05	.59334E-03	-.69735E-02
14.4000	2	.67034E+01	.46317E+00	.29540E+01	-.69818E-06	-.53869E-03	-.14423E-01
14.8000	2	.68693E+01	.28893E+00	-.17683E+01	.60638E-06	.58533E-03	-.51617E-02
15.2000	2	.70549E+01	.42030E+00	.40015E+00	.27672E-04	-.38394E-03	-.15623E-01

NUMBER OF POINTS	•	5
NUMBER OF DAMPING VALUES	•	1
PRINT COUNTER	•	0
INPUT DIMENSIONS COUNTER	•	2
PLOT COUNTER	•	1
PRINT COUNTER	•	1
INPUT TAPE NO.	•	8

NODE NUMBERS

1	8	9	13	14
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DAMPING VALUES

2.000

1.09819	.53171	29.77501	4.31513	5.96200
1.12390	.57518	31.47257	4.45680	5.91400
1.15022	.58117	31.07299	4.29956	5.87200
1.17714	.54884	28.67330	3.87676	5.83000
1.20470	.50101	25.57570	3.37884	6.97800
1.23291	.48009	23.94700	3.09130	6.93900
1.26177	.49099	23.93038	3.01849	11.25200
1.29131	.55340	26.35539	3.24832	12.30000
1.32154	.57664	26.83355	3.23160	12.61600
1.35248	.52174	23.72365	2.79171	12.56000
1.38414	.59519	26.48856	3.04577	6.86800
1.41655	.62843	27.28257	3.06531	6.82800
1.44971	.59346	25.17501	2.76381	7.12200
1.48365	.64965	26.92806	2.88264	13.65400
1.51839	.61399	24.85787	2.60661	14.14000
1.55393	.62513	24.73958	2.53385	2.17400
1.59031	.64565	24.95720	2.49866	2.16900
1.62754	.68943	26.05026	2.54741	14.65000
1.66565	.68617	25.33396	2.42070	5.65300
1.70464	.80765	29.13729	2.72042	5.30800
1.74455	.87922	30.99351	2.82753	5.26200
1.78539	.84978	29.27059	2.60926	5.22200
1.82719	.73110	24.60642	2.14331	2.35400
1.86997	.81548	26.81862	2.28256	12.05800
1.91375	.81697	26.25295	2.18330	12.00500
1.95855	.78136	24.53438	1.99370	2.34000
2.00440	.79341	24.34268	1.93287	2.33400
2.05133	.93151	27.92612	2.16668	5.19000
2.09935	1.00530	29.44879	2.23255	5.15400
2.14850	.93713	26.82381	1.98703	2.76400
2.19880	.97769	27.34469	1.97928	2.75000
2.25028	1.00838	27.55787	1.94908	2.73400
2.30296	1.02449	27.35764	1.89065	2.72000
2.35688	1.02293	26.69109	1.80239	2.70400
2.41205	1.00350	25.58524	1.68819	2.68300
2.46852	.98874	24.63218	1.58813	3.48200
2.52632	.97359	23.69984	1.49306	3.45800
2.58546	.95712	22.76606	1.40143	4.38300
2.64599	1.00582	23.37695	1.40611	4.36000
2.70794	.96831	21.99030	1.29245	2.63400
2.77133	1.02582	22.76354	1.30729	2.62200
2.83621	1.08487	23.52322	1.32001	2.61000
2.90261	1.12892	23.91825	1.31148	2.59300
2.97057	1.14857	23.77809	1.27397	2.58400
3.04011	1.14388	23.13917	1.21137	2.57200
3.11129	1.11836	22.10548	1.13079	2.56200
3.18412	1.07375	20.73823	1.03658	2.55000
3.25867	1.00301	18.92872	.92449	2.54200
3.33496	.89547	16.51269	.78804	2.53400
3.41304	.89773	16.17575	.75430	6.39400
3.49294	1.07257	18.88396	.85044	5.04400
3.57471	1.06681	18.35284	.81711	5.02200
3.65840	1.02433	17.21887	.74909	4.85400
3.74405	1.02326	16.80739	.71446	4.68400
3.83171	1.02804	16.49968	.68534	2.52800
3.92141	1.06428	16.69062	.67741	2.51600
4.01322	1.02594	15.72124	.62347	2.86800
4.10717	.95950	14.36685	.55672	14.59000
4.20333	.98270	14.37754	.54439	4.25400
4.30173	.95894	13.85198	.51249	4.23600
4.40244	.97874	13.67202	.49426	4.09600
4.50551	.98582	13.45581	.47532	4.07200
4.61099	1.06370	14.18674	.48968	2.82800
4.71894	1.07703	14.03592	.47339	2.81600
4.82942	1.07452	13.68292	.45092	2.69800
4.94248	1.07666	13.39649	.43139	2.69000

5.05819	1.05035	12.77012	.40181	2.68200
5.17661	1.00778	11.97235	.36809	2.67400
5.29780	1.00011	11.60937	.34877	2.66800
5.42183	.99987	11.22763	.32958	2.65900
5.54876	.88544	9.81343	.28148	2.64800
5.67867	.92126	9.97683	.27962	5.75600
5.81161	1.00628	10.64828	.29161	5.74200
5.94767	.96425	9.97010	.26679	5.73000
6.08591	.83053	8.39105	.21940	9.83200
6.22942	.85296	8.47970	.21665	5.71600
6.37526	.88819	8.55775	.21389	4.87200
6.52451	.95517	9.09729	.22191	4.63200
6.67726	.81099	7.46919	.17803	4.85200
6.83358	.78048	7.02377	.16358	13.43900
6.99357	.76344	6.71330	.15278	5.70000
7.15729	.72474	6.22713	.13847	13.62600
7.32486	.77318	6.49137	.14104	1.95400
7.49534	.80505	6.60435	.14022	2.35000
7.67184	.76598	6.14814	.12755	4.85000
7.85145	.84914	6.65097	.13482	4.84400
8.03526	.76380	5.84574	.11579	4.83900
8.22338	.76627	5.73043	.11091	4.83800
8.41590	.70392	5.14376	.09727	4.83000
8.61293	.70550	5.03737	.09308	1.93600
8.81457	.72448	5.05457	.09126	4.83000
9.02093	.72253	4.92566	.08590	4.82200
9.23212	.69304	4.54998	.07844	4.81800
9.44826	.63469	4.13113	.06959	2.34200
9.66946	.70796	4.50262	.07411	4.81000
9.89583	.59092	3.67223	.05906	2.69200
10.12751	.58207	3.53452	.05555	2.33400
10.36461	.55837	3.31307	.05087	4.74400
10.60726	.55679	3.22810	.04844	4.73600
10.85559	.52573	2.97831	.04367	3.58500
11.10973	.50252	2.78167	.03985	4.73600
11.36933	.55405	2.99678	.04195	4.68200
11.63601	.52123	2.75473	.03768	4.62400
11.90843	.52220	2.69675	.03604	2.33200
12.18722	.51045	2.57578	.03364	2.32800
12.47254	.54055	2.66523	.03401	3.56400
12.76454	.46373	2.23417	.02786	2.32600
13.06338	.46997	2.21245	.02695	5.68000
13.36921	.48643	2.23755	.02664	2.32800
13.68220	.51725	2.32489	.02704	2.32600
14.00252	.51267	2.25160	.02559	2.32200
14.33034	.48185	2.06784	.02297	2.32000
14.66583	.46669	1.95694	.02124	4.81600
15.00918	.41837	1.71419	.01818	4.81000
15.36056	.45221	1.81048	.01876	2.32200
15.72018	.44843	1.75426	.01776	2.32000
16.08821	.43592	1.66630	.01648	2.31800
16.46486	.42374	1.58270	.01530	2.31800
16.85032	.42890	1.56532	.01478	2.31800
17.24481	.42755	1.52470	.01407	2.31600
17.64854	.41652	1.45141	.01309	2.31400
18.06171	.40735	1.38696	.01222	2.31400
18.48456	.40305	1.34094	.01155	2.31200
18.91731	.37997	1.23521	.01039	2.31000
19.36019	.35546	1.12912	.00928	2.31000
19.81344	.33898	1.05214	.00845	2.31000
20.27730	.32094	.97335	.00764	2.31000
20.75202	.30937	.91681	.00703	2.31000
21.23786	.30243	.87572	.00656	2.31000
21.73507	.29804	.84327	.00617	2.31200
22.24391	.29484	.81514	.00583	2.31200
22.76468	.29223	.78945	.00552	2.31200

23.29763	.9023	.76509	.00523	2.31400
23.84306	.28871	.74466	.00497	2.31400
24.40126	.28732	.72412	.00472	2.31400
24.97253	.28610	.70456	.00449	2.31400
25.55717	.28498	.68575	.00427	2.31400
26.15550	.28394	.66761	.00406	2.31600
26.76783	.28324	.65072	.00387	2.31600
27.39451	.28254	.63427	.00368	2.31600
28.03585	.29191	.61838	.00351	2.31600
28.69221	.28130	.60292	.00334	2.31600
29.36393	.28074	.58796	.00319	2.31600
30.05138	.28019	.57339	.00304	2.31600
30.75493	.27969	.55927	.00289	2.31600
31.47494	.27921	.54555	.00276	2.31600
32.21182	.27876	.53220	.00263	2.31600
32.96594	.27834	.51923	.00251	2.31600
33.73772	.27798	.50670	.00239	2.31800
34.52757	.27768	.49458	.00228	2.31800
35.33591	.27740	.48277	.00217	2.31800
36.16317	.27713	.47127	.00207	2.31800
37.00980	.27687	.46006	.00198	2.31800
37.87625	.27663	.44914	.00189	2.31800
38.76299	.27640	.43851	.00180	2.31800
39.67048	.27618	.42814	.00172	2.31800
40.59922	.27597	.41803	.00164	2.31800
41.54971	.27578	.40818	.00156	2.31800
42.52245	.27559	.39857	.00149	2.31800
43.51796	.27542	.38921	.00142	2.31800
44.53677	.27526	.38008	.00136	2.31800
45.57944	.27510	.37118	.00130	2.31800
46.64652	.27496	.36250	.00124	2.31800
47.73858	.27482	.35403	.00118	2.31800

CALCOMP SPECTRA PLOT READY
 TITLE = SAMPLE PROBLEM 2 ...FFT...RIGID STRUCT.. WALL INTERACTION
 NODE NO. = 1
 DAMPING = 2.00000E+00 PERCENT
 PEAK G.S. = 1.14857E+00
 MAX SCALE = 1.30000E+01 G.S
 FIRSTY = 0. G.S
 DELTAA = 2.36364E-01 G.S/INCH
 FIRSTX = 0.
 DELTAX = 1.00000E+00
 IPOWER = -1

SAMPLE PROBLEM 2 ...FFT...RIGID STRUCT... WALL INTERACTION
 NODE POINT= 8 EQUIPMENT DAMPING= 2.00000E-02

SAMPLE PROBLEM 2 ...FFTF...RIGID STRUCT... WALL INTERACTION
 NODE POINT= 1 EQUIPMENT DAMPING= 2.00000E-02

SAMPLE PROBLEM 2 ...FFTF...RIGID STRUCT... WALL INTERACTION
 NODE POINT= 9 EQUIPMENT DAMPING= 2.00000E-02

SAMPLE PROBLEM 2 ...FFT...RIGID STRUCT.. WALL INTERACTION
 NODE POINT= 13 EQUIPMENT DAMPING= 2.00000E-02

SAMPLE PROBLEM 2 ...FFT...RIGID STRUCT.. WALL INTERACTION
 NODE POINT= 14 EQUIPMENT DAMPING= 2.00000E-02

2.0 PERCENT DAMPING NODE = 1

2.0 PERCENT DAMPING NODE = 8

2.0 PERCENT DAMPING NODE = 9

2.0 PERCENT DAMPING NODE = 13

APPENDIX D
Sample Problem 3
Output

SAMPLE PROBLEM 3 ...FFTF...RIGID BODY ..NO WALL INTERACTION

NO. OF NODES = 14
 NO. OF MODES = 0
 NO. OF SHEAR BEAMS = 13
 NO. OF ELEMENTS = 13
 NO. OF INERTIAS = 0
 TAPE COUNTER = 1

NODE AND MASS DATA			
NODE	LOCATION	WEIGHT	MASS
1	470.000	2800.000	86.957
2	474.000	6200.000	254.658
3	485.750	13000.000	403.727
4	493.000	18100.000	562.112
5	506.000	14890.000	462.422
6	515.000	11530.000	358.075
7	521.000	10130.000	314.596
8	529.000	14360.000	445.963
9	537.330	4530.000	140.683
10	547.000	27230.000	845.652
11	574.250	1215.000	37.733
12	601.500	1465.000	45.497
13	628.750	965.000	29.969
14	656.000	715.000	22.205

BASE INTERACTION NODE = 1
 PERCENT DAMP. HOR = -0.
 PERCENT DAMP. ROT = -0.

INTERACTION PARAMETERS AT BASE

NODE NO. = 1

SMOOR =	.11560E+05	RADB =	.17000E+03
KCFB =	.13000E+00	RATIOB =	.10000E+01
XKT =	.18611E+12	XKH =	.87592E+07
RHOC =	.68316E+01	ST =	.35113E+10
SM =	.55733E+06	XNUB =	.3500

SURK =	.87592E+07
SUMS =	.55733E+06
FREQ =	.74419E+01
CRITD =	.37484E+06
GM(MD-11) =	.40102E+04
PDAMP =	.14868E+03

SURKY =	.18611E+12
SUMSY =	.35113E+10
FREQ =	.12148E+03
CRITD =	.30641E+10
GM(MD) =	.34554E+07
AIBASE =	.12612E+08
YSTAR =	.47784E+02
PDAMP =	.11459E+03

1	.40102E+04	0.
2	.34554E+07	0.

FREE FIELD DATA FROM CAROS
ACCELERATION DATA DT = .10000E-01

THAX = .15000E+02
DT = .20000E-02
NOUT = 200
NOT = 1

NODES WHERE OUTPUT IS WANTED

2 TIME	NODE	DISPL	VEL	ACC	ROT	ROTD	ROTDU
0.0000							
.4000	2	0.	0.	0.	0.	0.	0.
.8000	2	.46543E-01	.28168E+00	.23906E+01	-.75294E-03	-.45568E-02	-.38672E-01
1.2000	2	.24522E+00	.56185E+00	-.82766E+00	-.39669E-02	-.90892E-02	.13389E-01
1.6000	2	.44886E+00	.50471E+00	.96611E+00	-.72613E-02	-.81647E-02	-.15629E-01
2.0000	2	.54210E+00	.72553E-01	.21017E+01	-.87696E-02	-.11737E-02	-.34000E-01
2.4000	2	.80778E+00	.46754E+00	-.77725E+01	-.13068E-01	-.75635E-02	.12574E+00
2.8000	2	.89601E+00	-.40991E-01	-.21823E+01	-.14495E-01	.66312E-03	.35304E-01
3.2000	2	.10484E+01	.66852E+00	-.19623E+01	-.16959E-01	-.10815E-01	.31745E-01
3.6000	2	.12962E+01	.36426E+00	-.79573E+00	-.20969E-01	-.58927E-02	.12873E-01
4.0000	2	.14347E+01	.63823E+00	.15847E+01	-.23209E-01	-.10325E-01	-.25636E-01
4.4000	2	.17008E+01	.49180E+00	.72742E+00	-.27514E-01	-.79559E-02	-.11768E-01
4.8000	2	.18874E+01	.13625E+00	.24180E+01	-.30533E-01	-.22042E-02	-.39117E-01
5.2000	2	.20153E+01	.43513E+00	-.43434E+01	-.32601E-01	-.70392E-02	.70264E-01
5.6000	2	.21250E+01	.70753E+00	.23590E+00	-.34377E-01	-.11446E-01	-.38162E-02
6.0000	2	.25037E+01	.86230E+00	.44834E+00	-.40503E-01	-.13950E-01	-.72528E-02
6.4000	2	.26995E+01	.33287E+00	-.12502E+01	-.43670E-01	-.53848E-02	.20224E-01
6.8000	2	.27928E+01	-.16257E-01	-.36616E+00	-.45179E-01	.26299E-03	.59234E-02
7.2000	2	.28991E+01	.77821E+00	.18331E+01	-.46900E-01	-.12557E-01	-.29654E-01
7.6000	2	.31769E+01	.80580E+00	.19202E+01	-.51394E-01	-.13036E-01	-.31083E-01
8.0000	2	.34509E+01	.51073E+00	-.49182E+00	-.55826E-01	-.82621E-02	.79562E-02
8.4000	2	.36008E+01	.51072E-01	-.52839E-01	-.58250E-01	-.82619E-03	.85479E-03
8.8000	2	.37274E+01	.67427E+00	.65043E+00	-.60298E-01	-.10908E-01	-.10522E-01
9.2000	2	.39050E+01	.43403E+00	-.32198E-01	-.63171E-01	-.70214E-02	.52088E-03
9.6000	2	.40775E+01	.62155E+00	.19104E+01	-.65962E-01	-.10055E-01	-.30905E-01
10.0000	2	.43317E+01	.54474E+00	-.21978E+01	-.70074E-01	-.88123E-02	.35554E-01
10.4000	2	.45352E+01	.43805E+00	-.63768E+00	-.73367E-01	-.70864E-02	.10316E-01
	2	.46279E+01	.12683E+00	.16348E+01	-.74866E-01	-.20517E-02	-.26447E-01

10.8000	2	.47410E+01	.67275E+00	.25130E+01	-.76696E-01	-.10883E-01	-.40653E-01
11.2000	2	.50202E+01	.46545E+00	-.22597E+00	-.81213E-01	-.75296E-02	.36555E-02
11.6000	2	.52744E+01	.56450E+00	-.25747E+01	-.85324E-01	-.91320E-02	.41651E-01
12.0000	2	.53487E+01	.32923E+00	.27094E+01	-.86527E-01	-.53260E-02	-.43830E-01
12.4000	2	.55542E+01	.50205E+00	-.12951E+01	-.89851E-01	-.81218E-02	.20968E-01
12.8000	2	.57205E+01	.42216E+00	.23578E+01	-.92541E-01	-.68293E-02	-.38142E-01
13.2000	2	.58942E+01	.46911E+00	-.36895E+00	-.95352E-01	-.75889E-02	.59686E-02
13.6000	2	.61206E+01	.68189E+00	-.19038E+01	-.99013E-01	-.11031E-01	.30798E-01
14.0000	2	.62960E+01	.43437E+00	.27341E+01	-.10185E+00	-.70269E-02	-.44229E-01
14.4000	2	.64518E+01	.27166E+00	-.16488E+01	-.10437E+00	-.43947E-02	.26673E-01
14.8000	2	.66262E+01	.39463E+00	.34832E+00	-.10719E+00	-.63839E-02	-.56349E-02

NUMBER OF POINTS	•	5
NUMBER OF DAMPING VALUES	•	1
PRINT COUNTER	•	0
INPUT DIMENSIONS COUNTER	•	2
PLOT COUNTER	•	1
PRINT COUNTER	•	1
INPUT TAPE NO.	•	8

NODE NUMBERS

1	8	9	13	14
---	---	---	----	----

DAMPING VALUES

2.000

CONTROL DATA READ OFF INPUT TAPE

ANAME = SAMPLE PROBLEM 3 ...FFTF...RIGID BODY ...NO WALL INTERACTION
 MD = 2
 NOD = 14
 DTI = .20000E-02
 TMAX = .15000E+02
 NRECS = 7499
 NODE = 1

NO. OF INPUT RECORDS = 7499
 FINAL DISPLACEMENT (IN.) = .86243E+02
 FINAL VELOCITY (IN/SEC) = .54157E+01
 PEAK ACCELERATION (G,S) = .27018E+00

NO. OF RECORDS ADDED = 259
 FINAL NO. OF RECORDS = 7758
 FINAL VELOCITY (IN/SEC) = 0.
 FINAL DISPLACEMENT (IN.) = .87631E+02
 TMAX. (DURATION, SECS) = .15514E+02

DAMPING RATIO= 2.00000E+00 PERCENT

FREQUENCY (CPS)	ACCELERATION (G,S)	VELOCITY (IPS)	DISPLACEMENT (IN)	MAX. TIME (SECS)
.50000	.22279	27.40174	8.72224	12.21800
.51171	.23666	28.44182	8.84621	12.13600
.52369	.24657	28.95529	8.79990	12.07200
.53595	.25439	29.19063	8.66848	12.01000
.54849	.25867	29.00195	8.41543	11.95600
.56133	.25125	27.52576	7.80438	11.88800
.57448	.25753	27.56902	7.63783	8.11600
.58792	.28413	29.72007	8.04541	8.07400
.60169	.30300	30.96892	8.19170	8.02800
.61578	.31741	31.69945	8.19312	8.74200
.63019	.32835	32.04225	8.09228	8.65800
.64495	.32591	31.07604	7.66872	8.59600
.66004	.30889	28.78025	6.93972	8.53600
.67550	.29135	26.52490	6.24958	12.01000
.69131	.32008	28.47334	6.55519	11.94400
.70750	.32719	28.44060	6.39787	12.53400
.72406	.34978	29.70832	6.53017	12.46000
.74101	.35943	29.82947	6.40680	12.39600
.75836	.33893	27.48505	5.76822	12.32000
.77611	.31158	24.68862	5.06282	15.47400
.79428	.31894	24.69407	4.94809	6.08000
.81288	.36232	27.41098	5.36685	6.03200
.83191	.39495	29.19578	5.58553	5.98000
.85138	.41305	29.83555	5.57736	5.92600
.87132	.40797	28.79440	5.25959	5.87600
.89172	.37739	26.02657	4.64527	5.81600
.91259	.40881	27.54872	4.80446	4.53600
.93396	.43558	28.68142	4.88758	4.49200
.95582	.45629	29.35750	4.88835	4.44600
.97820	.46824	29.43743	4.78953	4.41000
1.00110	.47244	29.02191	4.61390	4.84600
1.02454	.47894	28.74792	4.46579	4.81400
1.04852	.46306	27.15893	4.12244	4.78200
1.07307	.46300	26.53437	3.93551	6.02200

1.09919	.53083	29.72559	4.30796	5.96200
1.12390	.57423	31.42055	4.44944	5.91400
1.15022	.58017	31.01967	4.29218	5.87200
1.17714	.54794	28.62585	3.87034	5.83000
1.20470	.50060	25.55460	3.37606	6.97800
1.23291	.47963	23.92418	3.08836	6.93800
1.26177	.49055	23.90906	3.01580	11.25200
1.29131	.55297	26.33483	3.24579	12.30000
1.32154	.57654	26.82893	3.23104	12.61800
1.35248	.52154	23.71432	2.79062	12.56200
1.38414	.59594	26.47781	3.04451	6.86800
1.41655	.62808	27.26721	3.06358	6.82800
1.44971	.59392	25.19426	2.76592	7.12400
1.48365	.65014	26.94852	2.89084	13.65400
1.51839	.61438	24.88366	2.60827	14.14000
1.55393	.62559	24.75785	2.53572	2.17600
1.59031	.64612	24.98530	2.50047	2.16800
1.62754	.68984	26.06601	2.54895	14.65000
1.66565	.68708	25.36762	2.42391	5.66000
1.70464	.80853	29.16887	2.72337	5.30800
1.74455	.88061	31.04243	2.83199	5.26400
1.78539	.85115	29.31762	2.61346	5.22200
1.82719	.73377	24.69638	2.15114	2.35400
1.85997	.81709	26.87155	2.28706	12.06000
1.91375	.81876	26.31044	2.18808	12.00600
1.95855	.78399	24.61690	2.00041	2.34200
2.00440	.79595	24.42076	1.93907	2.33600
2.05133	.93398	28.00013	2.17243	5.19000
2.09935	1.00810	29.53088	2.23878	5.15400
2.14850	.94012	26.90955	1.99338	2.76400
2.19880	.99086	27.43320	1.98569	2.75000
2.25028	1.01167	27.64780	1.95544	2.73600
2.30296	1.02810	27.45391	1.89731	2.72000
2.35688	1.02663	26.78766	1.80891	2.70400
2.41205	1.00750	25.68709	1.69492	2.69000
2.46852	.99394	24.76166	1.59648	3.48400
2.52632	.97858	23.82122	1.50071	3.46000
2.58546	.96146	22.86922	1.40778	4.39000
2.64599	1.00998	23.47378	1.41194	4.36000
2.70794	.97350	22.10822	1.29938	2.53400
2.77133	1.03149	22.88938	1.31451	2.62400
2.83621	1.09110	23.65832	1.32759	2.61200
2.90261	1.13540	24.05573	1.31901	2.60000
2.97057	1.15557	23.92292	1.28173	2.58600
3.04011	1.15064	23.27593	1.21853	2.57400
3.11129	1.12473	22.23125	1.13722	2.56200
3.18412	1.07935	20.84633	1.04198	2.55200
3.25867	1.00781	19.01941	.92892	2.54200
3.33496	.89935	16.58430	.79146	2.53400
3.41304	.90162	16.24578	.75756	6.39600
3.49294	1.07729	18.96706	.86423	5.04600
3.57471	1.07196	18.44138	.82105	5.02400
3.65840	1.02911	17.29932	.75259	4.85400
3.74405	1.02557	16.84538	.71608	4.68400
3.83171	1.03060	16.54074	.68704	2.52800
3.92141	1.06666	16.72795	.67892	2.51800
4.01322	1.02833	15.75787	.62492	2.87000
4.10717	.96177	14.40073	.55804	14.59000
4.20333	.98487	14.40932	.54560	4.25600
4.30173	.97098	13.88117	.51357	4.23800
4.40244	.97978	13.68655	.49479	4.09600
4.50551	.98609	13.45956	.47545	4.07400
4.61099	1.06233	14.16844	.48904	2.83000
4.71894	1.07564	14.01779	.47278	2.81800
4.82942	1.07123	13.64102	.44954	2.70000
4.94248	1.07269	13.34705	.42979	2.69200

5.05819	1.04572	12.71387	.40004	2.68400
5.17661	1.00288	11.91405	.36630	2.67600
5.29780	.99459	11.54533	.34684	2.66800
5.42183	.98298	11.14948	.32729	2.66000
5.54876	.87837	9.73504	.27923	2.65000
5.67867	.91054	9.86073	.27638	5.75800
5.81161	.99439	10.52243	.28816	5.74400
5.94767	.95268	9.85045	.26359	5.73200
6.06691	.82118	8.29655	.21693	9.83400
6.22942	.84843	8.37584	.21399	5.71800
6.37526	.87580	8.44821	.21091	4.87400
6.52451	.95108	8.96448	.21867	4.05400
6.67726	.80006	7.36853	.17563	4.85400
6.83358	.76601	6.89354	.16055	13.44000
6.99357	.75209	6.61347	.15050	5.70200
7.15729	.71027	6.10283	.13571	13.62800
7.32486	.76340	6.40931	.13926	1.96400
7.49634	.79423	6.51559	.13833	2.35200
7.67184	.75350	6.04007	.12530	4.85200
7.85145	.83297	6.52436	.13225	4.84600
8.03526	.74890	5.73163	.11353	4.83000
8.22338	.75175	5.62186	.10881	4.83800
8.41590	.68924	5.03648	.09525	4.83000
8.61293	.69241	4.94389	.09136	1.93900
8.81457	.70875	4.94480	.08928	4.83000
9.02093	.70504	4.80640	.08480	4.82400
9.23212	.66624	4.43797	.07651	4.82000
9.44826	.62446	4.06456	.06847	2.34200
9.66946	.68676	4.36776	.07189	4.81200
9.89583	.57497	3.57312	.05747	2.69200
10.12751	.57271	3.47768	.05465	2.33600
10.36461	.53815	3.19304	.04903	4.74400
10.60726	.53521	3.10296	.04656	4.73800
10.85559	.50915	2.88437	.04229	3.58800
11.10973	.48192	2.66763	.03822	4.73800
11.36983	.53280	2.88185	.04034	4.68400
11.63601	.50731	2.68118	.03667	4.62600
11.90843	.51267	2.64753	.03538	2.33400
12.18722	.50215	2.53389	.03309	2.33000
12.47254	.52055	2.56663	.03275	3.56400
12.76454	.45573	2.19563	.02738	2.32600
13.06338	.45554	2.14452	.02613	5.68200
13.36921	.47692	2.19382	.02612	2.33000
13.68220	.50603	2.27444	.02646	2.32800
14.00252	.50175	2.20361	.02505	2.32400
14.33034	.47156	2.02365	.02247	2.32200
14.66583	.45203	1.89548	.02057	4.81800
15.00918	.40427	1.65642	.01756	4.81200
15.36056	.44221	1.77043	.01834	2.32200
15.72018	.43817	1.71412	.01735	2.32000
16.08821	.42565	1.62707	.01610	2.32000
16.46486	.41324	1.54347	.01492	2.32000
16.85032	.41855	1.52755	.01443	2.31800
17.24481	.41566	1.48230	.01368	2.31800
17.64854	.40550	1.41301	.01274	2.31600
18.06171	.39556	1.34681	.01187	2.31400
18.48456	.39102	1.30089	.01120	2.31400
18.91731	.36895	1.19941	.01009	2.31200
19.36019	.34476	1.09513	.00900	2.31000
19.81344	.32940	1.02239	.00821	2.31000
20.27730	.31248	.94771	.00744	2.31000
20.75202	.30173	.89416	.00686	2.31200
21.23786	.29585	.85669	.00642	2.31200
21.73507	.29163	.82514	.00604	2.31200
22.24391	.28902	.79905	.00572	2.31400
22.76468	.28691	.77508	.00542	2.31400

23.29763	.28512	.75262	.00514	2.31400
23.84306	.28371	.73175	.00488	2.31600
24.40126	.28260	.71223	.00465	2.31600
24.97253	.28164	.69356	.00442	2.31600
25.55717	.28073	.67550	.00421	2.31600
26.15550	.27985	.65800	.00400	2.31600
26.76783	.27908	.64117	.00381	2.31600
27.39451	.27851	.62523	.00363	2.31800
28.03585	.27801	.60982	.00346	2.31800
28.69221	.27751	.59480	.00330	2.31800
29.36393	.27705	.58023	.00314	2.31800
30.05138	.27660	.56603	.00300	2.31800
30.75493	.27618	.55224	.00286	2.31800
31.47494	.27578	.53883	.00272	2.31800
32.21182	.27539	.52577	.00260	2.31800
32.95594	.27503	.51307	.00248	2.31800
33.73772	.27469	.50071	.00236	2.31800
34.52757	.27438	.48870	.00225	2.32000
35.33591	.27414	.47710	.00215	2.32000
36.16317	.27390	.46579	.00205	2.32000
37.00980	.27368	.45476	.00196	2.32000
37.87625	.27347	.44401	.00187	2.32000
38.76299	.27326	.43353	.00178	2.32000
39.67048	.27307	.42331	.00170	2.32000
40.59922	.27288	.41334	.00162	2.32000
41.54971	.27270	.40362	.00155	2.32000
42.52245	.27253	.39414	.00148	2.32000
43.51796	.27237	.38490	.00141	2.32000
44.53677	.27221	.37588	.00134	2.32000
45.57944	.27206	.36708	.00128	2.32000
46.64652	.27192	.35849	.00122	2.32000
47.73858	.27179	.35012	.00117	2.32000

CALCOMP SPECTRA PLOT READY
TITLE = SAMPLE PROBLEM 3 ...FFTF...RIGID BODY ..NO WALL INTERACTION
NODE NO. = 1
DAMPING = 2.00000E+00 PERCENT
PEAK G.S = 1.15557E+00
MAX SCALE = 1.30000E+01 0.5
FIRSTY = 0. 0.5
DELTAA = 2.36364E-01 0.5/INCH
FIRSTX = 0.
DELTAX = 1.00000E+00
IPOWER = -1

SAMPLE PROBLEM 3 ...FFT...RIGID BODY...NO WALL INTERACTION
 NODE POINT= 1 EQUIPMENT DAMPING= 2.00000E-02

SAMPLE PROBLEM 3 ...FFT...RIGID BODY ...NO WALL INTERACTION
 NODE POINT= 8 EQUIPMENT DAMPING= 2.00000E-02

SAMPLE PROBLEM 3 ... FFTF ... RIGID BODY ... NO WALL INTERACTION
 NODE POINT= 9 EQUIPMENT DAMPING= 2.00000E-02

SAMPLE PROBLEM 3 ...FFT...RIGID BODY ..NO WALL INTERACTION
 NODE POINT= 13 EQUIPMENT DAMPING= 2.00000E-02

SAMPLE PROBLEM 3 ... FFTF ... RIGID BODY ... NO WALL INTERACTION
 NODE POINT= 14 EQUIPMENT DAMPING= 2.00000E-02

2.0 PERCENT DAMPING NODE = 1

2.0 PERCENT DAMPING NODE = 8

2.0 PERCENT DAMPING NODE = 9

2.0 PERCENT DAMPING NODE = 13

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