PREFACE

The work reported herein was performed for the National Aeronautics and Space Administrations's Marshall Space Flight Center under contract NAS8-33191, Supplemental Agreements 2 and 3. This effort involved the development of a computer program to perform Statistical Energy Analysis. This volume constitutes the final deliverable item under the contract. A card deck of the computer program was forwarded previously by MDAC letter A3-130-GWJ-1283.

Programming was accomplished by S. J. Nygaard, McDonnell Douglas Automation Company - Huntington Beach.
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Section 1
INTRODUCTION

Significant high frequency random vibration environments are generated during the operation of aerospace vehicles within the atmosphere. To achieve optimum vehicle design, vibration and acoustic criteria are developed early in the vehicle development program and are updated periodically as the design matures.

High frequency random vibration response prediction does not lend itself well to classical structural dynamics and such predictions are usually made by extrapolation from existing data banks. This method gives excellent results when similar structures are involved. However, as similarity decreases and associated extrapolations become large, uncertainty over accuracy also increases.

The efforts of numerous investigators (Maidanik, Lyons, et al.) have examined a more general high frequency random vibration analysis approach - the so-called Statistical Energy Analysis method. The SEA method is able to accomplish high frequency prediction of arbitrary structural configurations and is therefore a significant improvement over extrapolation methods when little or no previous data exist. The SEA method also represents a great improvement over normal mode methods for high frequency random vibration prediction because of the greatly reduced computational complexity associated with the more general SEA model elements and the attendant improvement in analysis turnaround time.

SEA has been developed for complex structures by MDAC under contract to MSFC (Ref. 1 and 2) over the past three years. The past year's effort has created a general SEA computer program which is described in this manual. The manual contains (1) a summary of SEA theory, (2) example problems of SEA program application, (3) a description of the computer program, and (4) a complete program listing (Appendices).
Section 2
A SUMMARY OF STATISTICAL ENERGY ANALYSIS PRINCIPLES

Statistical Energy Analysis (SEA) is a powerful tool for estimating the high frequency vibration spectra of complex systems. The analysis method is based on the estimation of the power flow between idealized gross elements of a vibrating system. The method is statistical in that averaging assumptions are made with regard to distribution of energy within an element, distribution of resonant modes, and the coupling between elements. These assumptions greatly simplify the computational complexity associated with normal mode methods. These same assumptions impose the limitation that point response predictions cannot be made.

The assumptions on which the method rests and their implications can be quite rigorously stated as follows:

1. The total vibrating system can be partitioned into SEA elements (with suitable boundary conditions) whose modes approximate the modes of the original vibrating system.

2. The modes of the elements of a system contain all of the vibratory energy of the system.

3. The energy in one frequency band of a system element is equally distributed among the modes of that element occurring in the frequency band.

4. Only modes occurring within the same frequency band are coupled.

5. For two coupled elements, all of the modes occurring in one of the elements in one frequency band are equally coupled to each mode occurring in the same frequency band in the other element.
Assumption 1 contains the fundamental existence basis for SEA: the concept of partitionability. This concept implies that a coupled vibrating system with system modes can be approximated by two or more separately idealized vibrating elements, each with its own independent mode set. These sets are coupled only in the sense of having power flow to and from each set across the partition boundary (later referred to as the "joint"). The approximation to this model exists in most structures having reflective boundaries in the higher frequencies. For example, a skin/stringer structure has higher order skin panel modes that are nearly the same frequency and shape as an ideally supported panel because the stringer is a comparatively massive boundary causing reflection of flexural waves from the skin panel. An SEA plate element could logically be equal to the panel area bounded by stringers or frames. Such elements will then have to be coupled with joint elements in order to develop an SEA model which emulates the vibratory power flow of the real structure.

Assumption 3 is the most important simplifying assumption of SEA because it eliminates the necessity to calculate generalized modal forces and responses. The conditions implicit in this assumption are usually approximated by the higher order modes of a structure in a reasonable bandwidth, say 1/3 octave. One-third octave bands represent a reasonable compromise between the necessity to get a fairly large number of modes (>20) in the band for good statistics and the necessity to have some frequency response resolution in the vibration prediction. The number of modes in a unit bandwidth can be estimated for simple structural forms (such as beams, plates, etc.) using algebraic expressions for modal density such as those given in Section 4 of this report. Estimation of modal density in this way is a considerable simplification over normal mode methods.

Given SEA elements with the properties described above it is now necessary to join them to permit power flow between the modes of one element and the modes of another. This is done with a parameter called the coupling loss factor $\phi$ and leads to assumptions 4 and 5. Assumption 4 is directly linked to assumption 2 and the further assumption of a linear process. Assumption 5 follows directly from assumption 3 as part of the simplification associated with a statistical rather than explicit description of modes.
With these properties and assumptions we can now write the SEA equation systems as follows:

\[
\begin{bmatrix}
\alpha_{11} & \alpha_{12} & \alpha_{13} & \cdots & \alpha_{1j} \\
\alpha_{21} & \alpha_{22} & \alpha_{23} & \cdots & \alpha_{2j} \\
\alpha_{31} & \alpha_{32} & \alpha_{33} & \cdots & \alpha_{3j} \\
\end{bmatrix}
\begin{bmatrix}
E_1 \\
E_2 \\
E_3 \\
\end{bmatrix} =
\begin{bmatrix}
S_1 \\
S_2 \\
S_3 \\
\end{bmatrix}
\]

(1)

where

\[
\begin{align*}
\alpha_{ij} &= \begin{cases} 
-N_i \phi_{ij} & \text{if } \ i \neq j \\
\omega_n + \sum_{k=1}^{M} N_k \phi_{ik} & \text{if } \ i = j 
\end{cases} \\
N_i &= \text{number of modes resonant in element } i \\
\eta_i &= \text{element } i \text{ loss factor} \\
\phi_{ij} &= \text{power transfer coefficient for coupling between modes in elements } i \text{ and } j \\
\omega &= \text{center frequency of bandwidth} \\
E_i &= m_i \frac{<a_i^2>}{\omega^2} = \text{total energy of element } i, <a_i^2> \text{ being the mean square acceleration} \\
S_i &= \text{external acoustic or mechanical excitation in the bandwidth of interest}
\end{align*}
\]

Note that the matrix \( \alpha \) is square but not symmetric. The lack of symmetry arises from the nature of the term \(-N_i \phi_{ij}\). Using the first two rows as an example the power balance equations are

\[
(\omega_n + \sum_{k=1}^{M} N_k \phi_{1k}) E_1 - N_1 \phi_{12} E_2 - N_1 \sum_{k=2}^{M} \phi_{1k} E_k = S_1
\]

\[
-N_2 \phi_{12} + (\omega_n + \sum_{k=1}^{M} N_k \phi_{2k}) E_2 - N_2 \sum_{k=2}^{M} \phi_{2k} E_k = S_2
\]
Note that the "symmetric" positions $a_{21}$ and $a_{12}$ actually carry the number of modes belonging to the row number only. This unsymmetric form preserves the power flow both to and from each element.

Each equation in the matrix states the following relationship for each element. The net power flow into element $i$ ($S_i$) equals the difference between (1) the power flow dissipated within the element ($\omega_n E_i$) plus the power flow lost to other elements across the joints

$$M E_i = \sum_{k=1}^{M} N_k \phi_{ik}$$

and (2) the power flow added to element $i$ from all other elements

$$N_i = \sum_{k=1}^{M} E_k \phi_{ik}, i \neq k$$

It must be remembered that the coupling term $\phi_{ik}$ has nothing to do with coupling modes; it only relates the fractional amount of energy resident in the modes of element $i$ that flows to the modes of element $k$.

For all but the simplest of systems even the SEA equations can be laborious to evaluate by hand. The computer program described in the following sections performs all of the computations necessary to evaluate terms and solves the above system of equations for element energies and prints the results as vibration PSD or RMS levels for all elements. This program relieves the analyst of the necessity to have an extensive knowledge of how to compute SEA parameters and permits the use of SEA model sizes that would otherwise be intractable. The program is described in detail in Section 2; some SEA modeling examples and corresponding program inputs are described in Section 3.
Section 3
EXAMPLES OF SEA PROGRAM APPLICATIONS

An SEA computer program has been developed that performs the organization of specific problem solutions for up to a 20-element system. A number of different element and joint types are available to describe a wide variety of structural forms in terms of an SEA model. Random acoustic or mechanical excitation can be applied in 1/3 octave bands to any arbitrary number of elements within a given model. The resulting equations are then solved giving the vibration response spectrum for each element. This section illustrates the use of SEA and the computer program with specific examples. The basic analysis procedure is divided into three steps:

1. Idealization
2. Parameter Generation
3. Problem Solution

The idealization step must be performed entirely by the user as it consists of modeling the physical structure in terms of available SEA program elements - a conceptual process. The second step is one of simply providing the proper data to the program which then carries out the third step. These steps will be illustrated below with specific examples, and the SEA program elements will be discussed in detail.

The idealization step is by far the most crucial step in the process. It is here that the art of engineering judgement must reach a well developed state, balancing the realities of the structural article to be analyzed with the capabilities and assumptions implicit in the SEA process to
obtain a useful engineering solution. Consider the model shown in Figure 3-1. This is the basic form of all SEA models. It consists of elements, denoted as boxes, which may be plates, beams, etc., and joints denoted by connecting lines which correspond to the physical interfaces at the selected partitions.

The model shows the articles included in each SEA element and the connection relationships between or among the elements. To gain a better understanding of what these elements and connections are it is helpful to now explain in detail the various types available in the computer program. Each of the elements is made up of one or more sub-elements, the first of which is the main sub-element. The sub-element system provides a convenient way to compute and include the modal density and mass properties of individual structural pieces that make up the element on a piece-by-piece basis. However, the sub-element with the most important property being modelled in that SEA element should always be the first or main sub-element. The joint properties must also be consistent with this sub-element as it is the only one that can be coupled to other SEA main elements. An example is given by element 1 of the model. This element has structure elements exposed to an acoustic field and those that are not. The most important property is the reception of acoustic excitation and transmission of vibration through its boundaries to other main elements. That portion must therefore be sub-element 1.

It is often the case that structures are made of different materials; this condition is taken into account when the program sets up the solution. The program automatically recomputes properties (thickness, density, etc.) to match the elastic modulus of element 1, sub-element 1. Furthermore, only sub-element 1 of each element can receive acoustic excitation; the others contribute only to the modal density and to the element mass. Sub-element 1 will always be used for the structure element that is the main piece of the given SEA element because all other properties except mass and modal density will be those of this sub-element.

The types of sub-elements available are beams, plates, cylinders, membrane, and reverberant room. In general, beams, plates and cylinders can
Figure 3-1. SEA Model Elements for Acoustic Test Configuration
be freely mixed in describing a structure. The membrane sub-element should only be used as an ancillary sub-element (i.e., sub-element number > 1). The room sub-element requires special treatment in that the loss factor must be developed from the reverberation time (n = 2.2/fT_{60}) and the answers must be converted from q^2 to pressure^2 using energy density relationship. The room sub-element must always be the only sub-element in that particular element.

Given these SEA elements, joint properties must now be developed to describe the power flow from the modes of one element to another. The program gives the user a choice of four types: (1) plate to plate, (2) beam to plate, (3) bolted joint, and (4) plate to acoustic. Each joint has two ends for accounting purposes and the word order used describes the A and B ends respectively. For example, in joint (2) the beam is always at the A end and plate is always at the B end. The joint loss factors are from the literature (cited in References 1 and 2) except for the bolted joint. This joint is a plate-to-plate joint with an additional insertion loss to account for internal losses in the joint due to fastener effects. The insertion loss is a load sheet input which provides to the user a more general purpose alternative to joints (1) and (2). Values of the insertion loss parameter for various fastener arrangements are not well defined, however, and must be the topic of continuing research. In the case of the Materials Experiment Assembly (MEA) analyzed during the last phase of this study, the empirically determined insertion loss factor was approximately 10 for each bolted joint.

With the basics of the program now given, two examples will be shown as a guide for program use. The first example will be a segment of skin stringer structure exposed to an acoustic field with an equipment panel on the opposite side. The second example will be a simplified MEA analysis.

The first case can be idealized with two SEA elements as shown in Figure 3-2. The relevant parameters are shown in the following table:
Skin Thickness .040"
Segment Dimensions 18" x 72"
Stringer Spacing 10" O.C.
Stringer Dimensions 1-1/2" high x 1" wide with 3/4 flanges, .063 thick (full hat section)
Internal Frames
Panel 400 in² of .063 thick aluminum
1" honeycomb with .020 face sheets
17 x 30 with 16 lb of small equipment items mounted on its surface.
Panel riveted to frames at four places (U-shaped channels) .063" thick x 1-1/2" high

The SEA element 1 shown in Figure 3-2 will consist of all structural elements in the table except the panel and its mounted equipment which is SEA element 2. From this information an elementary SEA analysis can be made. The load sheet entries are determined as follows and are shown in Figures 3-3 through 3-10 in the proper sequence.

Figure 3-2. Two-Element SEA Model Example

Figure 3-3 shows the header card which basically describes the problem as consisting of two elements and eleven 1/3 octave bands from 250 to 2500 Hz and that the output will be a vibration PSD. Figure 3-4 describes element 1 as consisting of two sub-elements, the first of which is exposed to acoustic excitation, and describes the damping vs. frequency curve. Figure 3-5 shows the 1/3 octave sound pressure levels; Figures 3-6 and 3-7 describe the sub-element properties in detail.
LOADSHEET (1): HEADER CARD
- One required per case
- First card in sequence

```
211 250.0  PSD
```

DATA ENTRY DESCRIPTION

<table>
<thead>
<tr>
<th>Card Columns</th>
<th>Value</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2</td>
<td>Integer</td>
<td>Total number of elements in model ($2 \leq E \leq 20$)</td>
</tr>
<tr>
<td>3-4</td>
<td>Integer</td>
<td>Total number of analysis frequencies ($1 \leq F \leq 40$) (Analysis frequencies are spaced 1/3 octave apart)</td>
</tr>
<tr>
<td>5-14</td>
<td>Real</td>
<td>Lowest analysis frequency</td>
</tr>
<tr>
<td>15</td>
<td>Alpha</td>
<td>Units: M = metric (MKS), default = English (in, lb, sec)</td>
</tr>
<tr>
<td>16-18</td>
<td>Alpha</td>
<td>Output mode; RMS or PSD</td>
</tr>
</tbody>
</table>

Figure 3-3. Card 1, Example Case 1
LOADSHEET (2): SEA ELEMENT PROPERTIES CARD

- One required for each element \(2 \leq E \leq 20\)
- Must be in ascending numerical sequence

<table>
<thead>
<tr>
<th>Card Column</th>
<th>Value</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2</td>
<td>Integer</td>
<td>Element number</td>
</tr>
<tr>
<td>3-4</td>
<td>Integer</td>
<td>Number of sub-elements ((SE \geq 1))</td>
</tr>
<tr>
<td>5</td>
<td>Alpha</td>
<td>Excitation type on this element (if any)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(A = \text{acoustic} \quad M = \text{direct mechanical})</td>
</tr>
<tr>
<td>6-8</td>
<td>Alpha</td>
<td>If (CC5 = A), leave blank; defaults to dB re 20 (\mu)bar</td>
</tr>
<tr>
<td></td>
<td></td>
<td>If (CC5 = M), RMS = 1/3 octave RMS g's</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PSD = (g^2/Hz) input at 1/3 octave centers</td>
</tr>
<tr>
<td>9-18</td>
<td>Real</td>
<td>Element loss factor constant ((\eta_0))</td>
</tr>
<tr>
<td>19-28</td>
<td>Real</td>
<td>Loss factor high frequency slope ((s))</td>
</tr>
<tr>
<td>29-38</td>
<td>Real</td>
<td>Loss factor crossover frequency ((f_0))</td>
</tr>
</tbody>
</table>

\[ \eta(f) = \eta_0 \left(\frac{f}{f_0}\right)^s \]

Figure 3-4. Card 2, Example Case 1
LOADSHEET (3): EXCITATION SPECTRUM CARD

- All entries are real numbers and must be consistent with LS #2, CC6-8 (units) and LS #1, CC 3-4.
- Make entries across in order of increasing frequency.

<table>
<thead>
<tr>
<th>Frequency (Hz)</th>
<th>Amplitude (units)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100.0</td>
<td>1.48</td>
</tr>
<tr>
<td>200.0</td>
<td>1.49</td>
</tr>
<tr>
<td>300.0</td>
<td>1.50</td>
</tr>
<tr>
<td>400.0</td>
<td>1.51</td>
</tr>
<tr>
<td>500.0</td>
<td>1.52</td>
</tr>
<tr>
<td>600.0</td>
<td>1.53</td>
</tr>
<tr>
<td>700.0</td>
<td>1.54</td>
</tr>
<tr>
<td>800.0</td>
<td>1.55</td>
</tr>
<tr>
<td>900.0</td>
<td>1.56</td>
</tr>
<tr>
<td>1000.0</td>
<td>1.57</td>
</tr>
</tbody>
</table>

Figure 3-5, Card 3, Example Case 1
LOADSHEET (4): SUB-ELEMENT PROPERTIES, CARDS 1 AND 2

- Must be consistent with Loadsheet 2, CC 3-4 (SE ≥ 1)
- Two cards (records) per sub-element
- Must follow associated element card and excitation card (if any)

DATA ENTRY DESCRIPTION

<table>
<thead>
<tr>
<th>Card Columns</th>
<th>Value</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Sub-element number (Sub-element 1 is always the main sub-element)</td>
</tr>
<tr>
<td>1-2</td>
<td>Integer</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Alpha</td>
<td>Sub-element type; B = beam, C = cylinder, M = membrane, P = plate R = room (acoustic element)</td>
</tr>
<tr>
<td>4-13</td>
<td>Real</td>
<td>Mass density (B, C, M, P, R)</td>
</tr>
<tr>
<td>14-23</td>
<td>Real</td>
<td>Elastic modulus (B, C, M, P)</td>
</tr>
<tr>
<td>24-33</td>
<td>Real</td>
<td>Thickness (B, C, M, P)</td>
</tr>
<tr>
<td>34-43</td>
<td>Real</td>
<td>Area (section if B; surface if M or P)</td>
</tr>
<tr>
<td>44-53</td>
<td>Real</td>
<td>Poisson's ratio (C, P)</td>
</tr>
<tr>
<td>54-63</td>
<td>Real</td>
<td>Length (B, C)</td>
</tr>
<tr>
<td>64-73</td>
<td>Real</td>
<td>Pressure (M only)</td>
</tr>
<tr>
<td>1</td>
<td>Logical</td>
<td>Replace F with T if stiffness increase is desired (B, C, P)</td>
</tr>
<tr>
<td>2-11</td>
<td>Real</td>
<td>Radius (C only)</td>
</tr>
<tr>
<td>Card 2</td>
<td>12-21</td>
<td>Volume (R only)</td>
</tr>
<tr>
<td>22-31</td>
<td>Real</td>
<td>Speed of sound - Sub-element 1 only and if (P) and CC5, LS2 = A, or (R) unconditionally</td>
</tr>
<tr>
<td>32-41</td>
<td>Real</td>
<td>Added non-structural mass (B, C, M, P)</td>
</tr>
</tbody>
</table>

Figure 3-6. Card 4, Example Case 1
LOADSHEET (4): SUB-ELEMENT PROPERTIES, CARDS 1 AND 2

- Must be consistent with Loadsheet 2, CC 3-4 (SE ≥ 1)
- Two cards (records) per sub-element
- Must follow associated element card and excitation card (if any)

DATA ENTRY DESCRIPTION

<table>
<thead>
<tr>
<th>Card Columns</th>
<th>Value</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2</td>
<td>Integer</td>
<td>Sub-element number (Sub-element 1 is always the main sub-element)</td>
</tr>
<tr>
<td>3</td>
<td>Alpha</td>
<td>Sub-element type; B = beam, C = cylinder, M = membrane, P = plate, R = room (acoustic element)</td>
</tr>
<tr>
<td>4-13</td>
<td>Real</td>
<td>Mass density (B, C, M, P, R)</td>
</tr>
<tr>
<td>14-23</td>
<td>Real</td>
<td>Elastic modulus (B, C, M, P)</td>
</tr>
<tr>
<td>24-33</td>
<td>Real</td>
<td>Thickness (B, C, M, P)</td>
</tr>
<tr>
<td>34-43</td>
<td>Real</td>
<td>Area (section if B; surface if M or P)</td>
</tr>
<tr>
<td>44-53</td>
<td>Real</td>
<td>Poisson's ratio (C, P)</td>
</tr>
<tr>
<td>54-63</td>
<td>Real</td>
<td>Length (B, C)</td>
</tr>
<tr>
<td>64-73</td>
<td>Real</td>
<td>Pressure (M only)</td>
</tr>
<tr>
<td>1</td>
<td>Logical</td>
<td>Replace F with T if stiffness increase is desired (B, C, P)</td>
</tr>
<tr>
<td>2-11</td>
<td>Real</td>
<td>Radius (C only)</td>
</tr>
<tr>
<td>Card 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12-21</td>
<td>Real</td>
<td>Volume (R only)</td>
</tr>
<tr>
<td>22-31</td>
<td>Real</td>
<td>Speed of sound - Sub-element 1 only and if (P) and CC5, LS2 = A, or (R) unconditionally</td>
</tr>
<tr>
<td>32-41</td>
<td>Real</td>
<td>Added non-structural mass (B, C, M, P)</td>
</tr>
</tbody>
</table>

Figure 3-7. Card 5, Example Case 1
Sub-element 1 consists of the skin and stringer elements. The skin is used as the principal property because it is the major element being excited by the acoustic field. The stringers are added as a smeared mass because their internal resonant frequencies are very high and therefore would be expected only to load the skin in the frequency range of interest. Sub-element 2 (Figure 3-7) represents the properties of the internal frames and channels which mount the panel.

Figures 3-6 and 3-9 show the loadsheets for the inside equipment panel. Figure 3-8 defines the panel as Element 2, with one sub-element and constant damping vs. frequency. Figure 3-9 has the panel properties which have been equivalenced to an isotropic plate because the panel is a composite structure. Note that both the thickness and the density have been changed to be consistent. Any other equivalence could also be used, e.g. leave the thickness = 1.0 and the density and Young's modulus will be recalculated using

\[
\frac{1}{T} \sum e^{i T_i} = \rho_{\text{eff}}
\]

and

\[
E_{\text{eff}} = \frac{12E(1-\nu^2)}{b t^3} \sum I_i
\]

There is no requirement that sub-elements be of similar materials, but all plate, beam and cylinder sub-element properties must always be isotropic equivalents.

The weight of the components is treated as a non-structural mass. If half or more of the panel area were covered with these components, the \( F \) should be changed to a \( T \) as shown on the sheet to account for the reduction of modal density associated with stiffening of the panel by the components as reported in Reference 2.

Figure 3-10 describes the joint properties between the skin and the plate. Note that an added insertion loss factor of 2 is used to account for rivet effects.
LOADSHEET (2): SEA ELEMENT PROPERTIES CARD

- One required for each element (2 ≤ E ≤ 20)
- Must be in ascending numerical sequence

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 |
| 2 | . | . | . | . | . | . | . | 0 | . | 0 | 5 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |

DATA ENTRY DESCRIPTION

<table>
<thead>
<tr>
<th>Card Column</th>
<th>Value</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2</td>
<td>Integer</td>
<td>Element number</td>
</tr>
<tr>
<td>3-4</td>
<td>Integer</td>
<td>Number of sub-elements (SE ≥ 1)</td>
</tr>
</tbody>
</table>
| 5 | Alpha | Excitation type on this element (if any)
  | | A = acoustic  
  | | M = direct mechanical |
| 6-8 | Alpha | If CC5 = A, leave blank; defaults to dB re 20 μbar
  | | If CC5 = M, RMS = 1/3 octave RMS g's
  | | PSD = g²/Hz input at 1/3 octave centers |
| 9-18 | Real | Element loss factor constant (n₀) |
| 19-28 | Real | Loss factor high frequency slope (s) |
| 29-38 | Real | Loss factor crossover frequency (f₀) |

such that \( \eta(f) = n₀ \left( \frac{f}{f₀} \right)^s \)

Figure 3-8. Card 6, Example Case 1
LOADSHEET (4): SUB-ELEMENT PROPERTIES, CARDS 1 AND 2

- Must be consistent with Loadsheet 2, CC 3-4 (SE ≥ 1)
- Two cards (records) per sub-element
- Must follow associated element card and excitation card (if any)

```
19     3.49E-5     10.0246     0.2     0.33
08     0.0416
```

DATA ENTRY DESCRIPTION

<table>
<thead>
<tr>
<th>Card Columns</th>
<th>Value</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-13</td>
<td>1-2 Integer</td>
<td>Sub-element number (Sub-element 1 is always the main sub-element)</td>
</tr>
<tr>
<td></td>
<td>3 Alpha</td>
<td>Sub-element type; B = beam, C = cylinder, M = membrane, P = plate</td>
</tr>
<tr>
<td></td>
<td></td>
<td>R = room (acoustic element)</td>
</tr>
<tr>
<td></td>
<td>4-13 Real</td>
<td>Mass density (B, C, M, P, R)</td>
</tr>
<tr>
<td>Card 1</td>
<td>14-23 Real</td>
<td>Elastic modulus (B, C, M, P)</td>
</tr>
<tr>
<td></td>
<td>24-33 Real</td>
<td>Thickness (B, C, M, P)</td>
</tr>
<tr>
<td></td>
<td>34-43 Real</td>
<td>Area (section if B; surface if M or P)</td>
</tr>
<tr>
<td></td>
<td>44-53 Real</td>
<td>Poisson's ratio (C, P)</td>
</tr>
<tr>
<td></td>
<td>54-63 Real</td>
<td>Length (B, C)</td>
</tr>
<tr>
<td></td>
<td>64-73 Real</td>
<td>Pressure (M only)</td>
</tr>
<tr>
<td></td>
<td>1 Logical</td>
<td>Replace F with T if stiffness increase is desired (B, C, P)</td>
</tr>
<tr>
<td></td>
<td>2-11 Real</td>
<td>Radius (C only)</td>
</tr>
<tr>
<td>Card 2</td>
<td>12-21 Real</td>
<td>Volume (R only)</td>
</tr>
</tbody>
</table>
|              | 22-31 Real | Speed of sound - Sub-element 1 only and if \( \begin{cases} \text{P} \text{ and CC5, LS2 = A, or} \\
\text{R} \text{ unconditionally} \end{cases} \) |
|              | 32-41 Real | Added non-structural mass (B, C, M, P) |

Figure 3-9. Card 7, Example Case 1
LOADSHEET (5): JOINT PROPERTIES

- Must follow all element and sub-element cards at end of deck.
- Must be consistent with elements being joined.

<table>
<thead>
<tr>
<th>Card Columns</th>
<th>Value</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2</td>
<td>Integer</td>
<td>Element number of A end of joint</td>
</tr>
<tr>
<td>3-4</td>
<td>Integer</td>
<td>Element number of B end of joint</td>
</tr>
<tr>
<td>5-6</td>
<td>Alpha</td>
<td>Joint type: PP = plate-to-plate, BP = beam-to-plate, BJ = bolted joint, PA = plate to acoustic</td>
</tr>
<tr>
<td>7-8</td>
<td>Integer</td>
<td>No. of sides exposed to acoustic input (1 or 2 for PA only)</td>
</tr>
<tr>
<td>9-18</td>
<td>Real</td>
<td>Joint length</td>
</tr>
<tr>
<td>19-28</td>
<td>Real</td>
<td>Thickness of A end of joint</td>
</tr>
<tr>
<td>29-38</td>
<td>Real</td>
<td>Thickness of B end of joint</td>
</tr>
<tr>
<td>39-48</td>
<td>Real</td>
<td>Acoustic space mass density (P/RT)</td>
</tr>
<tr>
<td>49-58</td>
<td>Real</td>
<td>Beam length (BP only)</td>
</tr>
<tr>
<td>59-68</td>
<td>Real</td>
<td>Energy reduction factor (BJ only)</td>
</tr>
</tbody>
</table>

Figure 3-10. Card 8, Example Case 1
These data are then assembled as a file which the program reads as an input.

The corresponding program output is shown in Figure 3-11 and consists of a labeled list of the input data, a display of the element modal densities, and a table of vibration responses. The adequacy of the SEA model with regard to assumptions 4 and 5 can be checked using the modal density tables of the figure. For example, element 1 contains more than 20 modes per 1/3 octave over the entire analysis range, whereas element 2 has far fewer. Since frequency response will be smoother with more modes per band, it is expected that the panel prediction will be poorer than the skin predictions. Specifically, the actual panel response may have some peaks which exceed the SEA prediction.

The SEA response prediction is shown in Table 3-1. The levels for element 1 are high compared to the criteria published in Reference 3, but one must remember that this estimate includes a space average over the skin. The stringer and frame vibration levels which are inputs to the panel are a factor of ~100 less.

Simple changes can be made to improve the prediction. For example, an internal acoustic field can be put on the panel by also placing an A in card column 5 of Figure 3-8 and entering the appropriate table immediately after, as shown in Figure 3-12. The results of this modification are shown in Table 3-2. As can be seen, the panel vibration increases considerably and critical frequency behavior is evident around 625 Hz. It should be noted that SEA often overpredicts in the critical frequency region. This simple example illustrates some of the possibilities of SEA with the help of this computer program.

A more extensive example is that of the MEA done in the previous phase. The input for this six-element model (Fig. 3-1) is extensive and much too elaborate to be explained in detail here, but the breakdown of the sub-elements used is given in Table 3-3. The input listing is given in Appendix III and the output is shown in Table 3-4.

A mechanical vibration input may also be applied if the known vibration level is included as an additional element. Load sheet 2 card column 5
**STATISTICAL ENERGY ANALYSIS OF COMPLEX STRUCTURES**

<table>
<thead>
<tr>
<th>RECORD NUMBER</th>
<th>DATA READ FROM UNIT 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>NUMBER OF ELEMENTS = 2</td>
</tr>
<tr>
<td></td>
<td>NUMBER OF ANALYSIS FREQUENCIES = 11</td>
</tr>
<tr>
<td></td>
<td>FIRST ANALYSIS FREQUENCY = 2.50000E+02</td>
</tr>
<tr>
<td></td>
<td>TYPE OF UNITS =</td>
</tr>
<tr>
<td></td>
<td>TYPE OF OUTPUT = PSD</td>
</tr>
<tr>
<td>2</td>
<td>ELEMENT NUMBER = 1</td>
</tr>
<tr>
<td></td>
<td>NUMBER OF SUB-ELEMENTS = 2</td>
</tr>
<tr>
<td></td>
<td>TYPE OF EXCITATION = A</td>
</tr>
<tr>
<td></td>
<td>TYPE OF MECHANICAL INPUT =</td>
</tr>
<tr>
<td></td>
<td>DAMPING = 1.00000E-01</td>
</tr>
<tr>
<td></td>
<td>SLOPE = -1.00000E+00</td>
</tr>
<tr>
<td></td>
<td>STARTING FREQUENCY = 2.50000E+02</td>
</tr>
<tr>
<td></td>
<td>SOUND PRESSURE LEVELS</td>
</tr>
<tr>
<td>3</td>
<td>1.00000E+02 1.97500E+02 1.45000E+02 1.90000E+02</td>
</tr>
<tr>
<td></td>
<td>1.49500E+02 1.50000E+02 1.50000E+02 1.50000E+02</td>
</tr>
<tr>
<td>4</td>
<td>1.50000E+02 1.50000E+02 1.50000E+02 1.50000E+02 0.0</td>
</tr>
<tr>
<td></td>
<td>0.0 0.0 0.0</td>
</tr>
<tr>
<td>5</td>
<td>SUB-ELEMENT NUMBER = 1</td>
</tr>
<tr>
<td></td>
<td>TYPE OF SUB-ELEMENT = P</td>
</tr>
<tr>
<td></td>
<td>DENSITY = 2.61700E-04</td>
</tr>
<tr>
<td></td>
<td>MODULUS OF ELASTICITY = 1.00000E+07</td>
</tr>
<tr>
<td></td>
<td>THICKNESS = 0.00000E+02</td>
</tr>
<tr>
<td></td>
<td>AREA = 1.23600E+03</td>
</tr>
<tr>
<td></td>
<td>POISSONS RATIO = 3.30000E-01</td>
</tr>
<tr>
<td></td>
<td>LENGTH = 0.0</td>
</tr>
<tr>
<td></td>
<td>PRESSURE = 0.0</td>
</tr>
<tr>
<td>6</td>
<td>STIFFNESS REDUCTION REQUIRED = F</td>
</tr>
<tr>
<td></td>
<td>RADIUS = 0.0</td>
</tr>
<tr>
<td></td>
<td>VOLUME = 0.0</td>
</tr>
<tr>
<td></td>
<td>SPEED OF SOUND IN ROOM MEDIUM = 1.34000E+04</td>
</tr>
<tr>
<td></td>
<td>ADDED MASS = 1.30500E-02</td>
</tr>
<tr>
<td>7</td>
<td>SUB-ELEMENT NUMBER = 2</td>
</tr>
<tr>
<td></td>
<td>TYPE OF SUB-ELEMENT = P</td>
</tr>
<tr>
<td></td>
<td>DENSITY = 2.61700E-04</td>
</tr>
<tr>
<td></td>
<td>MODULUS OF ELASTICITY = 1.30000E+07</td>
</tr>
<tr>
<td></td>
<td>THICKNESS = 1.30000E-02</td>
</tr>
<tr>
<td></td>
<td>AREA = 5.04300E+02</td>
</tr>
<tr>
<td></td>
<td>POISSONS RATIO = 3.30000E-01</td>
</tr>
<tr>
<td></td>
<td>LENGTH = 0.0</td>
</tr>
<tr>
<td></td>
<td>PRESSURE = 0.0</td>
</tr>
<tr>
<td>8</td>
<td>STIFFNESS REDUCTION REQUIRED = F</td>
</tr>
<tr>
<td></td>
<td>RADIUS = 0.0</td>
</tr>
<tr>
<td></td>
<td>VOLUME = 0.0</td>
</tr>
<tr>
<td></td>
<td>SPEED OF SOUND IN ROOM MEDIUM = 0.0</td>
</tr>
<tr>
<td></td>
<td>ADDED MASS = 0.0</td>
</tr>
</tbody>
</table>

(Continued)

Figure 3-11. Two-Element SEA Program Output - External Acoustic Excitation
ELEMENT NUMBER = 2
NUMBER OF SUB-ELEMENTS = 1
TYPE OF EXCITATION =
TYPE OF MECHANICAL INPUT =
DAMPING = 5.000000E-02
SLOPE = 0.
STARTING FREQUENCY = 0.

SJB ELEMENT NUMBER = 1
TYPE OF SJB ELEMENT = T
DENSITY = 3.430000E-05
MODULUS OF ELASTICITY = 1.000000E+12
THICKNESS = 3.000000E-01
AREA = 5.100000E+01
POISSONS RATIO = 3.300000E-01
LENGTH = 0.
PRESSURE = 0.

STIFFNESS REDUCTION REQUIRED = F
RADIUS = 0.
VOLUME = 0.
SPEED OF SOUND IN ROOM MEDIUM = 0.
ADDED MASS = 4.150000E-02

CENTER MODAL DENSITY - MODES/(RAD/SEC)

<table>
<thead>
<tr>
<th>FREQ(HZ)</th>
<th>ELEMENT 1</th>
<th>ELEMENT 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>250.00</td>
<td>5.36653E-02</td>
<td>6.26429E-04</td>
</tr>
<tr>
<td>312.50</td>
<td>5.36653E-02</td>
<td>3.26429E-04</td>
</tr>
<tr>
<td>400.00</td>
<td>5.36653E-02</td>
<td>4.26429E-04</td>
</tr>
<tr>
<td>500.00</td>
<td>5.36653E-02</td>
<td>4.26429E-04</td>
</tr>
<tr>
<td>625.00</td>
<td>5.36653E-02</td>
<td>6.26429E-04</td>
</tr>
<tr>
<td>797.50</td>
<td>5.36653E-02</td>
<td>6.26429E-04</td>
</tr>
<tr>
<td>1000.00</td>
<td>5.36653E-02</td>
<td>9.26429E-04</td>
</tr>
<tr>
<td>1250.00</td>
<td>5.36653E-02</td>
<td>9.26429E-04</td>
</tr>
<tr>
<td>1575.00</td>
<td>5.36653E-02</td>
<td>9.26429E-04</td>
</tr>
<tr>
<td>2000.00</td>
<td>5.36653E-02</td>
<td>4.26429E-04</td>
</tr>
<tr>
<td>2500.00</td>
<td>5.36653E-02</td>
<td>4.26429E-04</td>
</tr>
</tbody>
</table>

RECORD NUMBER
---------
DATA READ FROM UNIT 3
-------------

12 FIRST ELEMENT = 1
SECOND ELEMENT = 2
TYPE OF JOINT = BJ
NUMBER OF SIDES = 0
JOINT LENGTH = 3.600000E+01
THICKNESS OF FIRST ELEMENT = 4.000000E-02
THICKNESS OF SECOND ELEMENT = 3.000000E-01
ACOUSTIC SPACE DENSITY = 0.
BEAM LENGTH = 0.
INSERTION LOSS FACTOR = 2.000000E+00

Figure 3-11 (Continued)
Table 3-1
TWO-ELEMENT SEA VIBRATION PREDICTION
EXTERNAL ACOUSTIC EXCITATION

<table>
<thead>
<tr>
<th>Center Frequency (Hz)</th>
<th>PSD Levels (G^2/Hz)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Element 1</td>
<td>Element 2</td>
<td></td>
</tr>
<tr>
<td>250.0</td>
<td>4.90675E+01</td>
<td>3.38593E-01</td>
<td></td>
</tr>
<tr>
<td>312.5</td>
<td>3.59925E+01</td>
<td>2.37220E-01</td>
<td></td>
</tr>
<tr>
<td>400.0</td>
<td>2.53599E+01</td>
<td>1.58301E-01</td>
<td></td>
</tr>
<tr>
<td>500.0</td>
<td>2.11177E+01</td>
<td>1.25095E-01</td>
<td></td>
</tr>
<tr>
<td>625.0</td>
<td>1.53027E+01</td>
<td>8.85583E-02</td>
<td></td>
</tr>
<tr>
<td>787.5</td>
<td>1.17827E+01</td>
<td>6.21389E-02</td>
<td></td>
</tr>
<tr>
<td>1000.0</td>
<td>7.83661E+01</td>
<td>3.86783E-02</td>
<td></td>
</tr>
<tr>
<td>1250.0</td>
<td>5.44536E+00</td>
<td>2.51832E-02</td>
<td></td>
</tr>
<tr>
<td>1575.0</td>
<td>3.81675E+00</td>
<td>1.64492E-02</td>
<td></td>
</tr>
<tr>
<td>2000.0</td>
<td>2.72180E+00</td>
<td>1.08695E-02</td>
<td></td>
</tr>
<tr>
<td>2500.0</td>
<td>2.05294E+00</td>
<td>7.61286E-03</td>
<td></td>
</tr>
</tbody>
</table>
for that element would contain an M and the vibration spectrum description would follow. The only restriction is that this element may not also have an acoustic input as it will be eliminated in the solution because the energy level is already known.

The possible permutations and combinations of elements, sub-elements, and other factors which this computer program can create go far beyond the ability to document in this report. These few examples give some insight into the processes involved in the performance of SEA using this program. Although determination of some of the parameters such as damping and insertion loss is still a difficult and often obscure process which requires substantial future improvement, this computer program provides a significant step toward streamlining and simplifying SEA for the analyst.
LOADSHEET (3): EXCITATION SPECTRUM CARD

- Must immediately follow element properties if LS#2, CC5 ≠ blank
- All entries are real numbers, and must be consistent with LS #2, CC6-8 (units) and LS #1, CC 3-4 (no. of frequencies - 40 max)
- Make entries across in order of increasing frequency

```
146.5   147.0   147.6   147.5   148.0   148.5   149.0   149.5
```

Figure 3-12. Internal Acoustic Input Table for Example 1
Table 3-2
TWO-ELEMENT SEA VIBRATION PREDICTION
EXTERNAL AND INTERNAL ACOUSTIC EXCITATION

<table>
<thead>
<tr>
<th>Center Frequency (Hz)</th>
<th>PSD Levels (G^2/Hz)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Element 1</td>
</tr>
<tr>
<td>250.0</td>
<td>4.96984E+01</td>
</tr>
<tr>
<td>312.5</td>
<td>3.67160E+01</td>
</tr>
<tr>
<td>400.0</td>
<td>2.62012E+01</td>
</tr>
<tr>
<td>500.0</td>
<td>2.26604E+01</td>
</tr>
<tr>
<td>625.0</td>
<td>2.05716E+01</td>
</tr>
<tr>
<td>787.5</td>
<td>1.40047E+01</td>
</tr>
<tr>
<td>1000.0</td>
<td>8.75443E+00</td>
</tr>
<tr>
<td>1250.0</td>
<td>5.75084E+00</td>
</tr>
<tr>
<td>1575.0</td>
<td>3.94377E+00</td>
</tr>
<tr>
<td>2000.0</td>
<td>2.76144E+00</td>
</tr>
<tr>
<td>2500.0</td>
<td>2.06547E+00</td>
</tr>
</tbody>
</table>
Table 3-3
SUB-ELEMENT BREAKDOWN FOR MEA TEST CASE

<table>
<thead>
<tr>
<th>ELEMENT 1</th>
<th>ELEMENT 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sub-element</td>
<td>Sub-element</td>
</tr>
<tr>
<td>1</td>
<td>Thermal Panels</td>
</tr>
<tr>
<td>2</td>
<td>Orbiter Interface Panels</td>
</tr>
<tr>
<td>3</td>
<td>Support Structure</td>
</tr>
<tr>
<td>4</td>
<td>Radiator</td>
</tr>
<tr>
<td>5</td>
<td>Interface Support Structure</td>
</tr>
<tr>
<td>6</td>
<td>Signal Distributor Panel</td>
</tr>
<tr>
<td>7</td>
<td>Signal Distribution Box</td>
</tr>
<tr>
<td>8</td>
<td>Support Brace Assembly and Gusset</td>
</tr>
<tr>
<td>9</td>
<td>Pressure Sensor and Voltage Regulator Panels</td>
</tr>
<tr>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ELEMENT 2</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sub-element</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Power Distribution Panel</td>
</tr>
<tr>
<td>2</td>
<td>Power Distribution Box</td>
</tr>
<tr>
<td>3</td>
<td>Data Acquisition Cold Plate</td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Sub-element</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Sub-element</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Solenoid Panel</td>
</tr>
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<table>
<thead>
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<th>ELEMENT 5</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Sub-element</td>
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<tr>
<td>1</td>
<td>Battery Cold Plate</td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
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<table>
<thead>
<tr>
<th>ELEMENT 6</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Sub-element</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Experiment Mounting</td>
</tr>
<tr>
<td>2</td>
<td>Plates</td>
</tr>
</tbody>
</table>
### Table 3-4
**SEA COMPUTER PROGRAM OUTPUT**
**FOR MEA/Acoustic Excitation Case**

<table>
<thead>
<tr>
<th>CENTER FREQUENCY (Hz)</th>
<th>PSD LEVELS (G<strong>2</strong>/Hz)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ELEMENT 1</strong></td>
<td><strong>ELEMENT 2</strong></td>
</tr>
<tr>
<td>31.50</td>
<td>1.37117E+01</td>
</tr>
<tr>
<td>35.39</td>
<td>1.39434E+01</td>
</tr>
<tr>
<td>50.40</td>
<td>1.35352E+01</td>
</tr>
<tr>
<td>63.00</td>
<td>1.37834E+01</td>
</tr>
<tr>
<td>78.75</td>
<td>1.40473E+01</td>
</tr>
<tr>
<td>99.23</td>
<td>1.41146E+01</td>
</tr>
<tr>
<td>126.00</td>
<td>1.39473E+01</td>
</tr>
<tr>
<td>157.50</td>
<td>1.13790E+01</td>
</tr>
<tr>
<td>198.45</td>
<td>1.02517E+01</td>
</tr>
<tr>
<td>252.00</td>
<td>7.25089E-02</td>
</tr>
<tr>
<td>315.00</td>
<td>4.73043E-02</td>
</tr>
<tr>
<td>393.75</td>
<td>3.10091E-02</td>
</tr>
<tr>
<td>504.00</td>
<td>1.95717E-02</td>
</tr>
<tr>
<td>630.00</td>
<td>8.21163E-03</td>
</tr>
<tr>
<td>787.50</td>
<td>3.47357E-03</td>
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<td>9.28257E-02</td>
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<tr>
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<td>4.96000E-02</td>
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<tr>
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<td>2.77960E-02</td>
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<td>1.24863E-02</td>
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<td>5.74855E-03</td>
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<td>1.48151E-03</td>
</tr>
<tr>
<td>4040.00</td>
<td>8.43835E-04</td>
</tr>
</tbody>
</table>

**CENTER FREQUENCY (Hz)** | **PSD LEVELS (G**2**/Hz)** |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ELEMENT 5</strong></td>
<td><strong>ELEMENT 6</strong></td>
</tr>
<tr>
<td>31.50</td>
<td>3.09538E-03</td>
</tr>
<tr>
<td>39.38</td>
<td>3.55341E-03</td>
</tr>
<tr>
<td>50.40</td>
<td>3.13632E-03</td>
</tr>
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<td>63.00</td>
<td>2.92661E-03</td>
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<tr>
<td>78.75</td>
<td>2.71710E-03</td>
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<td>2.47660E-03</td>
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<td>126.00</td>
<td>2.21901E-03</td>
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<td>157.50</td>
<td>1.63920E-03</td>
</tr>
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<td>198.45</td>
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<td>3150.00</td>
<td>6.72712E-07</td>
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<tr>
<td>3937.50</td>
<td>3.76252E-07</td>
</tr>
<tr>
<td>5040.00</td>
<td>2.26942E-07</td>
</tr>
</tbody>
</table>
Section 4

SEA COMPUTER PROGRAM DESCRIPTION AND USAGE

This section describes the computer code and the input requirements for problem solutions.

The program was written in ASCII Fortran V for the MS\textsuperscript{C} UNIVAC 1108 with the EXEC8 operating system resident in the computer. The program is designed to be run in the demand/interactive mode using the system editor to assemble and sequence the load sheet information.

The SEA computer code uses a main program whose function is essentially to call the various subroutines in the correct order. First called are two subroutines, EPROP and JINPUT, which read user-supplied data. Then for each analysis frequency, three other subroutines (JPROP, EXCITE, and ANSWER) are called to perform the various calculations. The subroutine ANSWER calls the UNIVAC library subroutine GASSEM from SYS $^{*}$MATHSTAT$^{*}$. Finally, subroutine RITER is called to print the solution. The complete program listing is given in Appendix I and the program flow charts are given in Appendix II.

4.1 SUBROUTINE DESCRIPTION

Subroutine EPROP reads user-supplied data giving element and sub-element properties and calls one of five subroutines (BEAM, MEMBR, PLATE, ROOM, or CYLIN) to calculate element modal densities. See Appendix I for the list of variables read by EPROP. EPROP first reads a record giving the number of elements, number of analysis frequencies, the first frequency, and the type of units (metric or English). EPROP checks that the number of elements and analysis frequencies is within the bounds allowed by the program, since memory is reserved with maximum values in mind. Then EPROP creates a table of analysis frequencies by multiplying each element of a

4-1
predefined 1/3 octave table by the first frequency. The predefined table consists of a series of frequencies, each of which is approximately one-third octave higher than the preceding one, and the first one of which is equal to 1. EPROP then reads element properties. If the type of excitation indicated on this read operation is acoustic, EPROP then reads a list of sound pressure levels for each analysis frequency for this element. Next, sub-element properties are read. Included in sub-element properties is the type of sub-element. Depending on whether this is a beam, membrane, plate, room or cylinder, EPROP calls the appropriate subroutine to calculate the modal density.

Subroutines BEAM, MEMBR, PLATE, ROOM and CYLIN calculate the modal density for a sub-element which is a beam, membrane, plate, room or cylinder, respectively. First, the part of the equation which is not frequency dependent is calculated. If stiffness reduction has been indicated, this partial value is multiplied by $1/2$. Then for each analysis frequency, the rest of the modal density equation is computed and the result summed to element modal density. The sub-element mass is summed to the element mass. If this is the first sub-element for the given element, it is assumed to be the main sub-element and element properties other than mass are set equal to the properties of this sub-element. The following equations are used to calculate modal densities:

Beam:  
$$n(\omega) = \frac{L}{2\pi} \left(\omega \sqrt{\frac{E t^2}{12\rho}}\right)^{-\frac{1}{2}}$$

Membrane:  
$$n(\omega) = \frac{A_{\omega} \omega t}{2\pi S}$$

Plate:  
$$n(\omega) = \frac{A}{4\pi} \left(\frac{E t^2}{12\rho(1-\gamma^2)}\right)^{-\frac{1}{2}}$$

Room:  
$$n(\omega) = \frac{V_{\omega}^2}{2\pi^2 c^2}$$

Cylindrical shell:
$$n(\omega) = \frac{A}{4\pi} \left(\frac{E t^2}{12\rho(1-\gamma^2)}\right)^{-\frac{1}{2}}$$
$$\text{if } \omega r \left(\frac{\rho}{E}\right)^{1/2} > \frac{1}{E}$$

$$n(\omega) = \frac{A}{4\pi} \left(\frac{E t^2}{12\rho(1-\gamma^2)}\right)^{-\frac{1}{2}} \left(\omega r \left(\frac{\rho}{E}\right)^{1/2}\right)^{3/2}$$
$$\text{if } \omega r \left(\frac{\rho}{E}\right)^{1/2} < \frac{1}{E}$$
Subroutine JINPUT reads joint properties supplied by the user. See Appendix I for a list of the variables read by JINPUT. JINPUT checks that element numbers are within range (i.e., less than or equal to the number of elements in the system) and that no pair of element numbers is input more than once. JINPUT keeps a running total of the number of pairs input and continues reading until the end of file is encountered. JINPUT checks to see that at least one pair of elements was read.

Subroutine JPROP calculates coupling coefficients based on the data read by JINPUT, using one of the following equations, depending on the type of joint as read by JINPUT:

**Plate to plate at right angles:**

\[
\phi_{12} = \frac{1.07L}{\pi AN_2} \left( \omega t_1 \left( \frac{E}{\rho_1(1-\gamma^2)} \right) \right)^{1/2} t_2 \]

\[
A = n_2 t_1 \left( \frac{E}{12\rho_1(1-\gamma^2)} \right)
\]

\[
T = \begin{cases} 
\frac{8}{27} & \text{if } t_1 > \frac{t_2}{2} \\
\frac{t_1}{t_2} & \text{if } t_1 < \frac{t_2}{2}
\end{cases}
\]

**Beam to plate (cantilevered):**

\[
\phi_{12} = \frac{2\pi fb}{N_2 A L}
\]

**Plate to acoustic space:**

\[
\phi_{12} = \left( \frac{4.33\pi c_2^4}{f_0 \omega^2 V_2} \right) \left( \frac{\rho_1 \sigma}{\rho_A} \right)
\]
Bolted or riveted joints:

1) Calculate PHI as if for a plate-to-plate rigid joint.
2) Reduce PHI by insertion loss factor.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>FORTRAN Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>φ</td>
<td>PHI</td>
<td>Coupling Coefficient</td>
</tr>
<tr>
<td>L</td>
<td>JL</td>
<td>Joint Length</td>
</tr>
<tr>
<td>N</td>
<td>MODES</td>
<td>Number of Modes in Bandwidth</td>
</tr>
<tr>
<td>ω</td>
<td>OMEGA</td>
<td>2π Times the Frequency</td>
</tr>
<tr>
<td>t</td>
<td>T</td>
<td>Thickness</td>
</tr>
<tr>
<td>E</td>
<td>EE</td>
<td>Modulus of Elasticity</td>
</tr>
<tr>
<td>ρ</td>
<td>DENSE</td>
<td>Density</td>
</tr>
<tr>
<td>γ</td>
<td>EGAMMA</td>
<td>Poisson’s Ratio</td>
</tr>
<tr>
<td>TAU</td>
<td></td>
<td>Thickness Ratio</td>
</tr>
<tr>
<td>n</td>
<td>N</td>
<td>Modal Density</td>
</tr>
<tr>
<td>f</td>
<td>FREQ</td>
<td>Frequency</td>
</tr>
<tr>
<td>b</td>
<td>BW</td>
<td>Beam Width</td>
</tr>
<tr>
<td>c</td>
<td>EC</td>
<td>Speed of Sound in Room Medium</td>
</tr>
<tr>
<td>V</td>
<td>VOL</td>
<td>Volume</td>
</tr>
<tr>
<td>a</td>
<td>NS</td>
<td>Number of Sides</td>
</tr>
<tr>
<td>σ</td>
<td>SIGMA</td>
<td>Radiation Efficiency</td>
</tr>
<tr>
<td>ρA</td>
<td>ASD</td>
<td>Acoustic Space Density</td>
</tr>
</tbody>
</table>

Function SIGF returns a value for the radiation efficiency of a panel. A single argument, X, is passed to SIGF. The value of X is the ratio of the analysis frequency to the critical frequency. An internal table of 16 values of the log of the radiation efficiency for $0 < X < 4$ is maintained. The first value, 0, is the value of X for which SIGF is a minimum. When $X = 0$, SIGF = -1.8. Each subsequent value of the internal table is the value of X for which SIGF increases by 0.2 over the previous value. The 13th value in the table is 1. Since this is the 12th value after the 1st, SIGF = $12 \times 0.2 + (-1.8) = 0.6$ when $X = 1$. This is the maximum value of SIGF. SIGF = 0 for $X = 4$, the final value of the table. The value of SIGF is calculated by finding the least value of the table that is greater than X. This value and the preceding one give two values of SIGF that differ by 0.2. Linear interpolation is then used to find the actual value of SIGF.

Subroutine EXCITE calculates acoustic and mechanical energy inputs for the elements of the system. These values are initially set to 0. Then for each element, the acoustic or mechanical energy input is calculated.
according to the following equations, depending on the type of excitation as read by EPROP:

Acoustic: \[ S = \frac{0.66 \pi c^2 \sigma^2 <\rho^2> \sigma N}{\omega^3 m} \]
\[ <\rho^2> = 10^{SPL/10}(8.41 \times 10^{-10}) \]

Mechanical in grms: \[ E = \frac{m}{\omega^2} g^2 \sigma \text{rms} g^2 \]

Mechanical in PSD Levels: \[ E = \frac{m}{\omega^2} \text{PSD} g^2 \frac{f}{4.33} \]

<table>
<thead>
<tr>
<th>Symbol</th>
<th>FORTRAN Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>S</td>
<td>Acoustic Energy Input</td>
</tr>
<tr>
<td>c</td>
<td>EC</td>
<td>Speed of Sound in Room Medium</td>
</tr>
<tr>
<td>A</td>
<td>A</td>
<td>Surface Area Exposed to Sound Field</td>
</tr>
<tr>
<td>(\sigma)</td>
<td>SIGMA</td>
<td>Radiation Efficiency</td>
</tr>
<tr>
<td>N</td>
<td>MODES</td>
<td>Number of Modes in Bandwidth</td>
</tr>
<tr>
<td>(\omega)</td>
<td>OMEGA</td>
<td>(2\pi) Times the Frequency</td>
</tr>
<tr>
<td>m</td>
<td>MSUB</td>
<td>Mass</td>
</tr>
<tr>
<td>SPL</td>
<td>SPL</td>
<td>Sound Pressure Level</td>
</tr>
<tr>
<td>E</td>
<td>E</td>
<td>Element Energy Level</td>
</tr>
<tr>
<td>(g_{\text{rms}})</td>
<td>MECH</td>
<td>Mechanical Input</td>
</tr>
<tr>
<td>g</td>
<td>G</td>
<td>Gravitational Constant</td>
</tr>
<tr>
<td>PSD</td>
<td>MECH</td>
<td>Mechanical Input</td>
</tr>
<tr>
<td>f</td>
<td>FREQ</td>
<td>Frequency</td>
</tr>
</tbody>
</table>

Subroutine ANSWER solves the SEA system of equations for element energy levels. First, element damping is determined. If the damping is constant, it is equal to the value read by EPROP. Otherwise the following equation is used:

\[ n_2 = n_f \left(\frac{f}{f_s}\right)^s \]

<table>
<thead>
<tr>
<th>Symbol</th>
<th>FORTRAN Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>(n_2)</td>
<td>ETA2</td>
<td>Element Damping</td>
</tr>
<tr>
<td>(n_f)</td>
<td>ETA</td>
<td>Constant Level of Damping</td>
</tr>
<tr>
<td>(f_s)</td>
<td>SFREQ</td>
<td>Start Frequency</td>
</tr>
<tr>
<td>s</td>
<td>SLOPE</td>
<td>Slope</td>
</tr>
</tbody>
</table>

Next, the elements of the alpha matrix of equation 1, Section 1, are calculated.
If there are any elements for which the energy levels (the E matrix) are already known, these are eliminated from the equation as shown by the following example: Suppose the system has six elements and the second and fifth have known energy levels. Then the equation becomes:

\[
\begin{bmatrix}
\alpha_{11} & \alpha_{13} & \alpha_{14} & \alpha_{16} \\
\alpha_{31} & \alpha_{33} & \alpha_{34} & \alpha_{36} \\
\alpha_{41} & \alpha_{43} & \alpha_{44} & \alpha_{46} \\
\alpha_{61} & \alpha_{63} & \alpha_{64} & \alpha_{66}
\end{bmatrix}
\begin{bmatrix}
E_1 \\
E_3 \\
E_4 \\
E_6
\end{bmatrix}
= 
\begin{bmatrix}
S_1 - \alpha_{12}E_2 - \alpha_{15}E_5 \\
S_3 - \alpha_{32}E_2 - \alpha_{35}E_5 \\
S_4 - \alpha_{42}E_2 - \alpha_{45}E_5 \\
S_6 - \alpha_{62}E_2 - \alpha_{65}E_5
\end{bmatrix}
\]

Since (for example) \( S_1 = \alpha_{11}E_1 + \alpha_{12}E_2 + \alpha_{13}E_3 + \alpha_{14}E_4 + \alpha_{15}E_5 + \alpha_{16}E_6 \), it can be seen that this has the same solution as the original equation. ANSWER recalculates the values of the S matrix and calls SOLVE to eliminate the unnecessary rows and columns from the matrices and find the solution. The solution is then used to calculate the average acceleration with the formula

\[
<\alpha> = E \frac{\omega^2}{m}
\]

<table>
<thead>
<tr>
<th>Symbol</th>
<th>FORTRAN Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>(&lt;\alpha&gt;)</td>
<td>ABAR</td>
<td>Average Acceleration</td>
</tr>
<tr>
<td>E</td>
<td>E</td>
<td>Element Energy Levels</td>
</tr>
<tr>
<td>(\omega)</td>
<td>OMEGA</td>
<td>2(\pi) Times the Frequency</td>
</tr>
<tr>
<td>m</td>
<td>MASS</td>
<td>Mass</td>
</tr>
</tbody>
</table>

Subroutine SOLVE solves the SEA system of equations. It copies the alpha and S matrices to new matrices, leaving out those rows and columns which were to be eliminated. It then calls MATHSTAT library subroutine GASSEM to solve the equation. SOLVE then puts the solution in the element energy array \(E\), and subroutine RITER prints the solution.

4.2 PROGRAM USAGE

4.2.1 Deck Setup and Sequence

At present, the source program resides on element C of file S1, so that it is necessary to compile and collect it before execution. The program
reads the SEA load sheet data on logical unit 3, which must be created by
the user with the text editor or data processor, using the Q option so
that file 3 is in ASCII code. The following sequence of control state-
ments illustrates the creation of file 3 and the execution of the
program:

@RUN ...
@ASG,C 3.
@ED,IQ 3.
    Statements creating file 3
EXIT
@ASG,A S1
@FTN,N S1.C,REL
@MAP,IN SYM,ABS
LIB SYS$*MATHSTAT$.
LIB SYS$*MSFC$.
LIB SYS$*MSFC$.
END
@XQT ABS
@FIN

4.2.2 Input - Drum/Disk

The only input for the program is on logical unit 3, which contains the
user's data. This file consists of the following five types of records:

1. Initial information used to process the other records.
2. Element properties.
3. Sound pressure levels or mechanical inputs.
4. Sub-element properties.
5. Joint properties.

The arrangement of these records and their data elements is shown on the
following five loadsheet pages (Figures 4-1 through 4-5).
LOADSHEET (1): HEADER CARD

- One required per case
- First card in sequence

<table>
<thead>
<tr>
<th>Card Columns</th>
<th>Value</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2</td>
<td>Integer</td>
<td>Total number of elements in model (2 ≤ E ≤ 20)</td>
</tr>
<tr>
<td>3-4</td>
<td>Integer</td>
<td>Total number of analysis frequencies (1 ≤ F ≤ 40) (Analysis frequencies are spaced 1/3 octave apart)</td>
</tr>
<tr>
<td>5-14</td>
<td>Real</td>
<td>Lowest analysis frequency</td>
</tr>
<tr>
<td>15</td>
<td>Alpha</td>
<td>Units: M = metric (MKS), default = English (in, lb, sec)</td>
</tr>
<tr>
<td>16-18</td>
<td>Alpha</td>
<td>Output mode: RMS or PSD</td>
</tr>
</tbody>
</table>

Figure 4-1. Loadsheet 1
LOADSHEET (2): SEA ELEMENT PROPERTIES CARD

- One required for each element ($2 \leq E \leq 20$)
- Must be in ascending numerical sequence

<table>
<thead>
<tr>
<th>Card Column</th>
<th>Value</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2</td>
<td>Integer</td>
<td>Element number</td>
</tr>
<tr>
<td>3-4</td>
<td>Integer</td>
<td>Number of sub-elements ($SE \geq 1$)</td>
</tr>
<tr>
<td>5</td>
<td>Alpha</td>
<td>Excitation type on this element (if any)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$A =$ acoustic $\quad M =$ direct mechanical</td>
</tr>
<tr>
<td>6-8</td>
<td>Alpha</td>
<td>If $CC5 = A$, leave blank; defaults to dB re 20 µbar</td>
</tr>
<tr>
<td></td>
<td></td>
<td>If $CC5 = M$, RMS = 1/3 octave RMS g's</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PSD = $g^2$/Hz input at 1/3 octave centers</td>
</tr>
<tr>
<td>9-18</td>
<td>Real</td>
<td>If $CC5 = A$, input surface area exposed to acoustic excitation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(consistent units)</td>
</tr>
<tr>
<td>19-28</td>
<td>Real</td>
<td>Element loss factor constant($\eta_0$)</td>
</tr>
<tr>
<td>29-38</td>
<td>Real</td>
<td>Loss factor high frequency slope ($s$)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>such that $\eta(f) = \eta_0 \left(\frac{f}{f_0}\right)^s$</td>
</tr>
<tr>
<td>39-48</td>
<td>Real</td>
<td>Loss factor crossover frequency ($f_0$)</td>
</tr>
</tbody>
</table>

Figure 4-2. Loadsheet 2
LOADSHEET (3): EXCITATION SPECTRUM CARD

- Must immediately follow element properties if LS#2, CC5 ≠ blank
- All entries are real numbers, and must be consistent with LS #2, CC6-8 (units) and LS #1, CC 3-4 (no. of frequencies - 40 max)
- Make entries across in order of increasing frequency

Figure 4-3. Loadsheet 3
LOADSHEET (4): SUB-ELEMENT PROPERTIES, CARDS 1 AND 2

- Must be consistent with Loadsheet 2, CC 3-4 (SE ≥ 1)
- Two cards (records) per sub-element
- Must follow associated element card and excitation card (if any)

DATA ENTRY DESCRIPTION

<table>
<thead>
<tr>
<th>Card Columns</th>
<th>Value</th>
<th>Definition</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2</td>
<td>Integer</td>
<td>Sub-element number</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Alpha</td>
<td>Sub-element type; B = beam, C = cylinder, M = membrane, P = plate</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>R = room (acoustic element)</td>
<td></td>
</tr>
<tr>
<td>4-13</td>
<td>Real</td>
<td>Mass density (B, C, M, P, R)</td>
<td></td>
</tr>
<tr>
<td>Card 1 14-23</td>
<td>Real</td>
<td>Elastic modulus (B, C, M, P)</td>
<td></td>
</tr>
<tr>
<td>24-33</td>
<td>Real</td>
<td>Thickness (B, C, M, P)</td>
<td></td>
</tr>
<tr>
<td>34-43</td>
<td>Real</td>
<td>Area (section if B; surface if M or P)</td>
<td></td>
</tr>
<tr>
<td>44-53</td>
<td>Real</td>
<td>Poisson's ratio (C, P)</td>
<td></td>
</tr>
<tr>
<td>54-63</td>
<td>Real</td>
<td>Length (B, C)</td>
<td></td>
</tr>
<tr>
<td>64-73</td>
<td>Real</td>
<td>Pressure (M only)</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Logical</td>
<td>Replace F with T if stiffness increase is desired (B, C, P)</td>
<td></td>
</tr>
<tr>
<td>2-11</td>
<td>Real</td>
<td>Radius (C only)</td>
<td></td>
</tr>
<tr>
<td>Card 2 12-21</td>
<td>Real</td>
<td>Volume (R only)</td>
<td></td>
</tr>
<tr>
<td>22-31</td>
<td>Real</td>
<td>Speed of sound (R, or if LS #2, CC5 = A)</td>
<td></td>
</tr>
<tr>
<td>32-41</td>
<td>Real</td>
<td>Added non-structural mass (B, C, M, P)</td>
<td></td>
</tr>
</tbody>
</table>

Figure 4-4. Loadsheet 4
LOADSHEET (5): JOINT PROPERTIES

- Must follow all element and sub-element cards at end of deck.
- Must be consistent with elements being joined.

DATA ENTRY DESCRIPTION

<table>
<thead>
<tr>
<th>Card Columns</th>
<th>Value</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2</td>
<td>Integer</td>
<td>Element number of A end of joint</td>
</tr>
<tr>
<td>3-4</td>
<td>Integer</td>
<td>Element number of B end of joint</td>
</tr>
<tr>
<td>5-6</td>
<td>Alpha</td>
<td>Joint type: PP = plate-to-plate, BP = beam-to-plate, BJ = bolted joint, PA = plate to acoustic</td>
</tr>
<tr>
<td>7-8</td>
<td>Integer</td>
<td>No. of sides exposed to acoustic input (1 or 2)</td>
</tr>
<tr>
<td>9-18</td>
<td>Real</td>
<td>Joint length</td>
</tr>
<tr>
<td>19-28</td>
<td>Real</td>
<td>Thickness of A end of joint</td>
</tr>
<tr>
<td>29-38</td>
<td>Real</td>
<td>Thickness of B end of joint</td>
</tr>
<tr>
<td>39-48</td>
<td>Real</td>
<td>Acoustic space mass density (P/RT)</td>
</tr>
<tr>
<td>49-58</td>
<td>Real</td>
<td>Beam length (BP only)</td>
</tr>
<tr>
<td>59-68</td>
<td>Real</td>
<td>Bolt spacing (BJ only)</td>
</tr>
</tbody>
</table>

Figure 4-5. Loadsheet 5
4.2.3 Output - Printout
The output consists of a list of input parameters, calculated modal densities, and calculated PSD levels (or $G_{\text{rms}}$), if this was specified on input by the user) for each element for each analysis frequency, arranged in five columns below a heading. The first column is the frequencies, the other four columns list the PSD levels for elements 1 to 4. This is followed by five more columns below a new heading and containing the frequencies and PSD levels for elements 5 to 8. This is repeated until all the elements have been listed.

4.2.4 Program Diagnostic Messages
The program can produce the error messages listed below. Suggestions for their cause and correction are also given. Lower case x's indicate values (usually, but not always, integers) that depend on the particular error.

*** ERROR *** THE INPUT FILE IS EMPTY. THE END OF FILE WAS ENCOUNTERED WHILE TRYING TO READ THE FIRST INPUT RECORD. THIS ERROR WAS DISCOVERED BY SUBROUTINE EPROP.

*** ERROR *** WHILE TRYING TO READ ELEMENT PROPERTIES, THE END OF FILE WAS ENCOUNTERED BEFORE INPUT RECORD xxxx. THIS ERROR WAS DISCOVERED BY SUBROUTINE EPROP.

*** ERROR *** WHILE TRYING TO READ SUB-ELEMENT PROPERTIES, THE END OF FILE WAS ENCOUNTERED BEFORE INPUT RECORD xxxx. THIS ERROR WAS DISCOVERED BY SUBROUTINE EPROP.

*** ERROR *** WHILE TRYING TO READ SOUND PRESSURE LEVELS, THE END OF FILE WAS ENCOUNTERED BEFORE INPUT RECORD xxxx. THIS ERROR WAS DISCOVERED BY SUBROUTINE EPROP.

*** ERROR *** WHILE TRYING TO READ MECHANICAL INPUTS, THE END OF FILE WAS ENCOUNTERED BEFORE INPUT RECORD xxxx. THIS ERROR WAS DISCOVERED BY SUBROUTINE EPROP.
*** ERROR *** THE END OF FILE WAS REACHED BEFORE ANY INFORMATION ABOUT JOINT PROPERTIES WAS READ. THIS ERROR WAS DISCOVERED BY SUBROUTINE JINPUT.

These errors are the result of an incomplete data file. The data file cannot end before joint properties for at least one pair of elements are read. The message indicates what kind of data the program was looking for when the end of file was encountered.

*** ERROR *** A FORTRAN ERROR OCCURRED WHILE TRYING TO READ ELEMENT PROPERTIES ON INPUT RECORD xxxx. THIS ERROR WAS DISCOVERED BY SUBROUTINE EPROP.

*** ERROR *** A FORTRAN ERROR OCCURRED WHILE TRYING TO READ SUB-ELEMENT PROPERTIES ON INPUT RECORDS xxxx AND xxxx. THIS ERROR WAS DISCOVERED BY SUBROUTINE EPROP.

*** ERROR *** A FORTRAN ERROR OCCURRED WHILE TRYING TO READ THE FIRST INPUT RECORD. THIS ERROR WAS DISCOVERED BY SUBROUTINE EPROP.

*** ERROR *** A FORTRAN ERROR OCCURRED WHILE TRYING TO READ SOUND PRESSURE LEVELS ON OR BEFORE INPUT RECORD xxxx. THIS ERROR WAS DISCOVERED BY SUBROUTINE EPROP.

*** ERROR *** A FORTRAN ERROR OCCURRED WHILE TRYING TO READ MECHANICAL INPUTS ON OR BEFORE INPUT RECORD xxxx. THIS ERROR WAS DISCOVERED BY SUBROUTINE EPROP.

*** ERROR *** WHILE ATTEMPTING TO READ JOINT PROPERTIES, A FORTRAN ERROR OCCURRED ON INPUT RECORD xxxx. THIS ERROR WAS DISCOVERED BY SUBROUTINE JINPUT.

A FORTRAN error is usually the result of invalid characters appearing in a data field; for example, alphabetic characters appearing where the program expects to read an integer. This is likely to occur if data records are missing or out of order; for example, if an element properties record says there are four sub-elements for that element, but records
for only three sub-elements are present. A FORTRAN error on the first record may indicate that the data file was not given the name 3. If the external file name is not 3, the internal file name should be made 3 by a USE statement.

*** ERROR *** THE NUMBER OF ELEMENTS WAS GIVEN AS xx. IT MUST BE BETWEEN 2 AND 20 INCLUSIVE. THIS ERROR WAS DISCOVERED BY SUBROUTINE EPROP.

*** ERROR *** THE NUMBER OF ANALYSIS FREQUENCIES WAS GIVEN AS xx. IT MUST BE BETWEEN 1 AND 40 INCLUSIVE. THIS ERROR WAS DISCOVERED BY SUBROUTINE EPROP.

*** ERROR *** THE TYPE OF MECHANICAL INPUT GIVEN FOR ELEMENT xx ON INPUT RECORD xxxx IS xxx. THIS IS NOT A VALID TYPE. THE TYPE MUST BE RMS OR PSD. THIS ERROR WAS DISCOVERED BY SUBROUTINE EPROP.

*** ERROR *** TYPE xx ON INPUT RECORD xxxx IS AN INVALID TYPE. TYPE MUST BE B, M, P, C, OR R. THIS ERROR WAS DISCOVERED BY SUBROUTINE EPROP.

*** ERROR *** THE TYPE OF JOINT GIVEN FOR ELEMENT PAIR xx AND xx ON INPUT RECORD xxxx IS xx. THIS IS NOT A VALID TYPE. THE TYPE MUST BE PP, BP, BJ, OR PA. THIS ERROR WAS DISCOVERED BY SUBROUTINE JPROP.

*** ERROR *** THE DETERMINANT OF THE SEA EQUATION MATRIX IS O. HENCE THERE IS NO SOLUTION. THIS ERROR WILL CAUSE THE PROGRAM TO ABORT. THIS ERROR WAS DISCOVERED BY SUBROUTINE SOLVE.

These messages are self explanatory. If any of the errors listed thus far occur, the subroutine in which they occur will continue processing. Before control is transferred to another subroutine, however, the following message is printed and the program is aborted through a CALL FERR statement:

BECAUSE OF THE ERRORS LISTED ABOVE, THE SEA PROGRAM WILL ABORT.
The following errors will not cause the program to abort, but may put the results in error:

*** WARNING *** ON INPUT RECORD xxxxy THE ELEMENT NUMBER WAS GIVEN AS xx, WHICH IS OUT OF ORDER. IT HAS BEEN CHANGED TO xx. THIS ERROR WAS DISCOVERED BY SUBROUTINE EPROP.

Element properties are stored in arrays in the order in which they are read. If elements are referenced in the joint properties section in any other order, that is, when they are referenced as one element of a pair, the results are almost certainly erroneous.

*** WARNING *** ON INPUT RECORD xxxxy THE SUB-ELEMENT NUMBER WAS GIVEN AS xx, WHICH IS OUT OF ORDER. IT SHOULD BE xx. THIS ERROR WAS DISCOVERED BY SUBROUTINE EPROP.

Sub-element properties are not stored in arrays so this is not likely to result in an error. If other errors occur, this message probably indicates that there are missing or extraneous records.

*** WARNING *** ON INPUT RECORD xxxxy, ONE OR BOTH MEMBERS OF THE ELEMENT PAIR xx AND xx WAS EITHER LESS THAN 1 OR GREATER THAN xx, THE TOTAL NUMBER OF ELEMENTS. THIS PAIR WILL BE IGNORED. THIS ERROR WAS DISCOVERED BY SUBROUTINE JINPUT.

*** WARNING *** THE ELEMENT PAIR xx AND xx ON INPUT RECORD xxxxy WAS PREVIOUSLY READ ON INPUT RECORD xxxxy. THE FIRST VALUES WILL BE USED. THIS ERROR WAS DISCOVERED BY SUBROUTINE JINPUT.

*** WARNING *** ON INPUT RECORD xxxxy, BOTH ELEMENT NUMBERS WERE GIVEN AS xx. THEY MUST BE DIFFERENT. THIS RECORD WILL BE IGNORED. THIS ERROR WAS DISCOVERED BY SUBROUTINE JINPUT.

These errors result in the indicated record being ignored. Whether or not the results are erroneous depends on whether the indicated record is necessary to the results.

In addition, data which causes overflow, negative arguments to the square root functions, etc., will produce ASCII FORTRAN diagnostics.
Section 5
REFERENCES


Appendix I

SEA PROGRAM FORTRAN LISTING
11/4/81

FINAL SEA

UNIVAC
C *************** SEA PROGRAM ***************
C
C
STATISTICAL ENERGY ANALYSIS OF COMPLEX STRUCTURES
C
C
C INPUT IS READ FROM UNIT 3 IN ASCII CODE
C OUTPUT IS WRITTEN TO UNIT 6, THE PRINTER (OR TERMINAL IN DEMAND MODE)
C THE FOLLOWING VARIABLES ARE USED IN THIS PROGRAM UNIT:
C NAME TYPE DESCRIPTION
C ---- ---- -----------
C AF INT ANALYSIS FREQUENCY ORDINAL (FROM 1 TO NUMAF)
C FREQ REAL FREQUENCY
C FRE(HF) REAL TABLE OF ANALYSIS FREQUENCIES
C NUMAF INT NUMBER OF ANALYSIS FREQUENCIES
C OMEGA REAL 2*PI*FREQUENCY
C
C THE FOLLOWING COMMON BLOCKS ARE USED:
C BLOCK OTHER PROGRAM UNITS USING THIS COMMON BLOCK
C
C
C
INTEGER I
LOGICAL ERROR
COMMON /CB1/ FTAB1(NUMAF,FREQ)
COMMON /CB2/ ERROR
COMMON /CB3/ FREQAF,OMEGA
DATA PI /3.1415926/
2C FORMAT (1B1,18E15.8)
* 1 WILL ABORT, 1
RETURN
C CALL EPFIF TO READ ELEMENT PROPERTIES INPUT
C CALL EPFIF (AS)
C CALL JINPUT TO READ JOINT PROPERTIES INPUT
C CALL JINPUT
C IF AN ERROR HAS OCCURRED ON INPUT, WRITE A MESSAGE AND
C TERMINATE THE PROGRAM.
C IF (.NOT. ERROR) GO TO 10
WRITE (*,30)
CALL FERM
C DO FOR EACH ANALYSIS FREQUENCY
10 DO 20 AF = 1,NUMAF

C DEFINE THE CURRENT ANALYSIS FREQUENCY
FREQ = FTAB(AF)
OMEGA = 2.*PI*FREQ
C CALL JPROP TO CALCULATE JOINT PROPERTIES
C CALL JPROP
C CALL EXCITE TO DETERMINE ENERGY SOURCES FROM EXCITATION INPUTS
C CALL EXCITE
C CALL ANSWER TO SOLVE THE SEA EQUATIONS FOR ELEMENT ENERGIES
C CALL ANSWER
C CONTINUE
20 CONTINUE
```
SUBROUTINE FPROP

C THIS SUBROUTINE READS ELEMENT AND SLR-ELEMENT PROPERTIES FROM UNIT
C AND CALLS THE APPROPRIATE SUBROUTINE, DEPENDING ON THE TYPE OF
C SUB-ELEMENT, TO CALCULATE ELEMENT MODAL DENSITIES. FPROP IS CALLED
C FROM THE MAIN PROGRAM.

C THE FOLLOWING VARIABLES ARE USED IN THIS PROGRAM UNIT:

<table>
<thead>
<tr>
<th>NAME</th>
<th>TYPE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>REAL</td>
<td>AREA</td>
</tr>
<tr>
<td>C</td>
<td>REAL</td>
<td>SPEED OF SOUND IN ROOM MEDIUM</td>
</tr>
<tr>
<td>C</td>
<td>REAL</td>
<td>MODULUS OF ELASTICITY</td>
</tr>
<tr>
<td>C</td>
<td>INT</td>
<td>ELEMENT NUMBER</td>
</tr>
<tr>
<td>C</td>
<td>REAL</td>
<td>DAMPING</td>
</tr>
<tr>
<td>C</td>
<td>REAL</td>
<td>TYPE OF EXCITATION</td>
</tr>
<tr>
<td>C</td>
<td>REAL</td>
<td>FIRST ANALYSIS FREQUENCY</td>
</tr>
<tr>
<td>C</td>
<td>REAL</td>
<td>TABLE OF ANALYSIS FREQUENCIES</td>
</tr>
<tr>
<td>C</td>
<td>REAL</td>
<td>GRAVITATIONAL CONSTANT</td>
</tr>
<tr>
<td>C</td>
<td>REAL</td>
<td>POISSON'S RATIO</td>
</tr>
<tr>
<td>C</td>
<td>REAL</td>
<td>GRAVITATIONAL CONSTANT IN METRIC UNITS</td>
</tr>
<tr>
<td>C</td>
<td>INT</td>
<td>NUMBER OF INPUT RECORDS READ</td>
</tr>
<tr>
<td>C</td>
<td>REAL</td>
<td>LENGTH</td>
</tr>
<tr>
<td>C</td>
<td>REAL</td>
<td>PASS</td>
</tr>
<tr>
<td>C</td>
<td>LOG</td>
<td>TRUE IF SUB-ELEMENT IS MAIN SUB-ELEMENT</td>
</tr>
<tr>
<td>C</td>
<td>REAL</td>
<td>MECHANICAL INPUT</td>
</tr>
<tr>
<td>C</td>
<td>REAL</td>
<td>TYPE OF MECHANICAL INPUT</td>
</tr>
<tr>
<td>C</td>
<td>INT</td>
<td>NUMBER OF ANALYSIS FREQUENCIES</td>
</tr>
<tr>
<td>C</td>
<td>INT</td>
<td>NUMBER OF ELEMENTS</td>
</tr>
<tr>
<td>C</td>
<td>INT</td>
<td>NUMBER OF SUB-ELEMENTS</td>
</tr>
<tr>
<td>C</td>
<td>CHAR</td>
<td>TYPE OF OUTPUT</td>
</tr>
<tr>
<td>C</td>
<td>REAL</td>
<td>RADIUS</td>
</tr>
<tr>
<td>C</td>
<td>REAL</td>
<td>DENSITY</td>
</tr>
<tr>
<td>C</td>
<td>REAL</td>
<td>PRESSURE</td>
</tr>
<tr>
<td>C</td>
<td>REAL</td>
<td>STARTING FREQUENCY</td>
</tr>
<tr>
<td>C</td>
<td>REAL</td>
<td>SLOPE</td>
</tr>
<tr>
<td>C</td>
<td>REAL</td>
<td>SOUND PRESSURE LEVEL</td>
</tr>
<tr>
<td>C</td>
<td>LOG</td>
<td>TRUE IF STIFFNESS REDUCTION REQUIRED</td>
</tr>
<tr>
<td>C</td>
<td>INT</td>
<td>SUB-ELEMENT NUMBER</td>
</tr>
<tr>
<td>C</td>
<td>REAL</td>
<td>THICKNESS</td>
</tr>
<tr>
<td>C</td>
<td>CHAR</td>
<td>TYPE OF SUB-ELEMENT</td>
</tr>
<tr>
<td>C</td>
<td>CHAR</td>
<td>TYPE OF UNIT</td>
</tr>
<tr>
<td>C</td>
<td>REAL</td>
<td>VOLUME</td>
</tr>
</tbody>
</table>

C THE FOLLOWING COMMON BLOCKS ARE USED:

C THE FOLLOWING COMMON BLOCKS ARE USED:
```

```
CHARACTER TYPE1,ETYPE1,MTYPE1,UNIT1,OTYPE1
INTEGER FLNM1,SUMNM1
REAL MEHM1,LNM1
LOGICAL ERROR1,STIFF1,MAIN
COMMON /C1/ ETAH1(40),NUMA1,FREQ1
COMMON /C2/ ERROR1
COMMON /C3/ FLNM1,SUMNM1,ETYPE1,STIFF1,LNM1,MAIN
COMMON /C5/ THICK1(40),AREA1(40),DENS1(20),VOL1(20),LIE1(20)

* E6MA20,EC1(20)

CPCHR /CBE/ SLP(20,40),STIFF1(20,40),AMM1(20),ETYPE1,MTYPE1
CPCHR /CBE/ SFREQ1(20),ETA1(20),OTYPE1
CPCHR /CBE/ INPUT1

DATA 61/*/1/

380 FORMAT (2I2,F10.2,A1,A3)
139 FORMAT (2I2,F10.2,A1,A3)
320 FORMAT (I2,A1,F10.2,A1,F10.2)

330 FORMAT (1E*** ERROR *** TYPE = A1* ON INPUT RECORD 1*)
1 I4* IS AN INVALID TYPE*A* TYPE MUST BE B, M, P, C, OR R*1/

$ IF THIS ERROR WAS DISCOVERED BY ROUTINE EPROP1*

340 FORMAT (1E*** ERROR *** A FORTRAN ERROR OCCURRED WHILE 1*)
$ IF THIS ERROR WAS DISCOVERED BY ROUTINE EPROP1*

1 TRYING TO READ/1 SUB-ELEMENT PROPERTIES ON INPUT RECORD 1*
2 I4* AND I4* ENTER 1/

$ IF THIS ERROR WAS DISCOVERED BY ROUTINE EPROP1*

350 FORMAT (1E*** ERROR *** A FORTRAN ERROR OCCURRED WHILE 1*)
$ IF THIS ERROR WAS DISCOVERED BY ROUTINE EPROP1*

1 TRYING TO READ/1 SUB-ELEMENT PROPERTIES ON INPUT RECORD 1*
2 I4* ENTER 1/

360 FORMAT (1E*** ERROR *** A FORTRAN ERROR OCCURRED WHILE 1*)
$ IF THIS ERROR WAS DISCOVERED BY ROUTINE EPROP1*

1 TRYING TO READ/1 THE FIRST INPUT RECORD 1/

370 FORMAT (1E*** ERROR *** THE INPUT FILE IS EMPTY, THE 1*)
$ IF THIS ERROR WAS DISCOVERED BY ROUTINE EPROP1*

1 END OF FILE WAS ENCOUNTERED1 WHILE TRYING TO READ THE 1*
2 FIRST INPUT RECORD 1/

380 FORMAT (1E*** ERROR *** THE INPUT FILE WAS ENCOUNTERED BEFORE 1*)
$ IF THIS ERROR WAS DISCOVERED BY ROUTINE EPROP1*

390 FORMAT (1E*** ERROR *** WHILE TRYING TO READ ELEMENT 1*)
$ IF THIS ERROR WAS DISCOVERED BY ROUTINE EPROP1*

400 FORMAT (A10,2)

410 FORMAT (1E*** ERROR *** A FORTRAN ERROR OCCURRED WHILE 1*)
$ IF THIS ERROR WAS DISCOVERED BY ROUTINE EPROP1*

1 TRYING TO READ/1 SOUND PRESSURE LEVELS ON OR BEFORE INPUT 1*
2 RECORD 1,14,1,1/

420 FORMAT (1E*** ERROR *** WHILE TRYING TO READ SOUND 1*)
$ IF THIS ERROR WAS DISCOVERED BY ROUTINE EPROP1*

1 PRESSURE LEVELS1,1/ THE END OF FILE WAS ENCOUNTERED 1*
2 BEFORE INPUT RECORD 1,14,1,1/

$ IF THIS ERROR WAS DISCOVERED BY ROUTINE EPROP1*

420 FORMAT (1E*** WARNING *** ON INPUT RECORD 1,14,1,1 THE 1*)
SUBROUTINE EPROP

1) ELEMENT NUMBER WAS GIVEN AS 1,12,1, WHICH IS OUT OF 1.
2) ICI=11, IT WAS CHANGED TO 1,12,1,.
3) THIS ERROR WAS DISCOVERED BY SUBROUTINE EPROP.
4) 44C FORMAT (18*** ERROR *** WARNING *** ON INPUT RECORD 1,14,1, IT IS 1, 14,1,.
5) 1) SUB-ELEMENT NUMBER WAS GIVEN AS 1,12,1, WHICH IS OUT OF 1.
6) ICI=11, IT SHOULD BE 1,12,1,.
7) THIS ERROR WAS DISCOVERED BY SUBROUTINE EPROP.
8) 44C FORMAT (18*** ERROR *** THE NUMBER OF ELEMENTS 1, 12,1, WHICH IS OUT OF 1.
9) 1) WAS GIVEN AS 1,12,1, IT MUST BE 1 BETWEEN 2 AND 20, 1,.
10) 2) NONLINES.
11) 1) THIS ERROR WAS DISCOVERED BY SUBROUTINE EPROP.
12) 44C FORMAT (18*** ERROR *** THE NUMBER OF ANALYSIS FREQUENCIES 1, 12,1, WHICH IS OUT OF 1.
13) 1) WAS GIVEN AS 1,12,1, IT MUST BE 1 BETWEEN 1 AND 40, 1,.
14) 2) INCLUDST.
15) 1) THIS ERROR WAS DISCOVERED BY SUBROUTINE EPROP.
16) 490 FORMAT (18*** ERROR *** A FORTRAN ERROR OCCURRED WHILE 1.
17) 1) TRYING TO READ/1 MECHANICAL INPUTS ON OR BEFORE INPUT 1.
18) 2) ICI=11,1,.
19) 1) THIS ERROR WAS DISCOVERED BY SUBROUTINE EPROP.
20) 44C FORMAT (18*** ERROR *** WHILE TRYING TO READ 1.
21) 1) THE MECHANICAL INPUTS 1,1, THE END OF FILE WAS ENCOUNTERED 1.
22) 2) ICI=11,1,.
23) 1) THIS ERROR WAS DISCOVERED BY SUBROUTINE EPROP.
24) 44C FORMAT (18*** ERROR *** THE TYPE OF MECHANICAL INPUT 1.
25) 1) WAS GIVEN FOR ELEMENT 1,12,1, ON INPUT RECORD 1,14,1, IT IS 1.
26) 2) A4,1, THIS IS NOT A VALID TYPE. THE TYPE MUST 1.
27) 1) BE REAL OR POS,1.
28) 1) THIS ERROR WAS DISCOVERED BY SUBROUTINE EPROP.
29) 500 FORMAT (18*** ERROR *** THE TYPE OF OUTPUT 1.
30) 1) WAS GIVEN FOR ELEMENT 1,12,1, ON INPUT RECORD 1,14,1, IT IS 1.
31) 2) A4,1, THIS IS NOT A VALID TYPE. THE TYPE MUST 1.
32) 1) BE REAL OR POS,1.
33) 1) THIS ERROR WAS DISCOVERED BY SUBROUTINE EPROP.
34) 500 FORMAT (18*** ERROR *** THE NUMBER OF ANALYSIS FREQUENCIES 1, 12,1, WHICH IS OUT OF 1.
35) 1) WAS GIVEN AS 1,12,1, IT MUST BE 1 BETWEEN 1 AND 40, 1,.
36) 2) INCLUDST.
37) 1) THIS ERROR WAS DISCOVERED BY SUBROUTINE EPROP.
38) 44C FORMAT (18*** ERROR *** THE NUMBER OF ELEMENTS 1, 12,1, WHICH IS OUT OF 1.
39) 1) WAS GIVEN AS 1,12,1, IT SHOULD BE 1 BETWEEN 2 AND 20, 1,.
40) 2) NONLINES.
41) 1) THIS ERROR WAS DISCOVERED BY SUBROUTINE EPROP.
42) 44C FORMAT (18*** ERROR *** WARNING *** ON INPUT RECORD 1,14,1, IT IS 1, 14,1,.
43) 1) SUB-ELEMENT NUMBER WAS GIVEN AS 1,12,1, WHICH IS OUT OF 1.
44) 2) ICI=11, IT SHOULD BE 1,12,1,.
45) 1) THIS ERROR WAS DISCOVERED BY SUBROUTINE EPROP.
46) 44C FORMAT (18*** ERROR *** THE NUMBER OF ANALYSIS FREQUENCIES 1, 12,1, WHICH IS OUT OF 1.
47) 1) WAS GIVEN AS 1,12,1, IT MUST BE 1 BETWEEN 1 AND 40, 1,.
48) 2) INCLUDST.
49) 1) THIS ERROR WAS DISCOVERED BY SUBROUTINE EPROP.
50) 44C FORMAT (18*** ERROR *** THE NUMBER OF ELEMENTS 1, 12,1, WHICH IS OUT OF 1.
51) 1) WAS GIVEN AS 1,12,1, IT SHOULD BE 1 BETWEEN 2 AND 20, 1,.
52) 2) NONLINES.
53) 1) THIS ERROR WAS DISCOVERED BY SUBROUTINE EPROP.
54) 44C FORMAT (18*** ERROR *** THE TYPE OF MECHANICAL INPUT 1.
55) 1) WAS GIVEN FOR ELEMENT 1,12,1, ON INPUT RECORD 1,14,1, IT IS 1.
56) 2) A4,1, THIS IS NOT A VALID TYPE. THE TYPE MUST 1.
57) 1) BE REAL OR POS,1.
58) 1) THIS ERROR WAS DISCOVERED BY SUBROUTINE EPROP.
59) 500 FORMAT (18*** ERROR *** THE TYPE OF OUTPUT 1.
60) 1) WAS GIVEN FOR ELEMENT 1,12,1, ON INPUT RECORD 1,14,1, IT IS 1.
61) 2) A4,1, THIS IS NOT A VALID TYPE. THE TYPE MUST 1.
62) 1) BE REAL OR POS,1.
63) 1) THIS ERROR WAS DISCOVERED BY SUBROUTINE EPROP.
64) 500 FORMAT (18*** ERROR *** THE NUMBER OF ANALYSIS FREQUENCIES 1, 12,1, WHICH IS OUT OF 1.
65) 1) WAS GIVEN AS 1,12,1, IT MUST BE 1 BETWEEN 1 AND 40, 1,.
66) 2) INCLUDST.
67) 1) THIS ERROR WAS DISCOVERED BY SUBROUTINE EPROP.
68) 44C FORMAT (18*** ERROR *** THE NUMBER OF ELEMENTS 1, 12,1, WHICH IS OUT OF 1.
69) 1) WAS GIVEN AS 1,12,1, IT SHOULD BE 1 BETWEEN 2 AND 20, 1,.
70) 2) NONLINES.
71) 1) THIS ERROR WAS DISCOVERED BY SUBROUTINE EPROP.
72) 44C FORMAT (18*** ERROR *** WARNING *** ON INPUT RECORD 1,14,1, IT IS 1, 14,1,.
73) 1) SUB-ELEMENT NUMBER WAS GIVEN AS 1,12,1, WHICH IS OUT OF 1.
74) 2) ICI=11, IT SHOULD BE 1,12,1,.
75) 1) THIS ERROR WAS DISCOVERED BY SUBROUTINE EPROP.
76) 44C FORMAT (18*** ERROR *** THE NUMBER OF ANALYSIS FREQUENCIES 1, 12,1, WHICH IS OUT OF 1.
77) 1) WAS GIVEN AS 1,12,1, IT MUST BE 1 BETWEEN 1 AND 40, 1,.
78) 2) INCLUDST.
79) 1) THIS ERROR WAS DISCOVERED BY SUBROUTINE EPROP.
80) 44C FORMAT (18*** ERROR *** THE NUMBER OF ELEMENTS 1, 12,1, WHICH IS OUT OF 1.
81) 1) WAS GIVEN AS 1,12,1, IT SHOULD BE 1 BETWEEN 2 AND 20, 1,.
82) 2) NONLINES.
C \textbf{WRITE THE HEADING FOR THE OUTPUT} \hfill \textbf{AUG26 29}
\textbf{WRITE (6,520)} \hfill \textbf{AUG26 30}

C \textbf{READ HOW MANY ELEMENTS AND ANALYSIS FREQUENCIES THERE ARE, THE} \hfill \textbf{EPREP1 27}
C \textbf{FIRST FREQUENCY, THE SYSTEM OF UNITS, AND THE TYPE OF OUTPUT} \hfill \textbf{EPREP1 144}
\textbf{READ (13,380,ERR=210,END=220),NUMEL,NUMAF,FREQ1,UNITS,OTYPE} \hfill \textbf{EPREP1 145}

C \textbf{WRITE THE FIRST RECORD TO OUTPUT} \hfill \textbf{AUG26 31}
\textbf{WRITE (6,530) NUMEL,NUMAF,FREQ1,UNITS,OTYPE} \hfill \textbf{EPREP1 146}

C \textbf{CHECK TO SEE THAT THE NUMBER OF ELEMENTS AND ANALYSIS} \hfill \textbf{EPREP1 147}
C \textbf{FREQUENCIES IS WITHIN RANGE} \hfill \textbf{EFOP 148}
\textbf{IF (NUMEL .LE. 2 .OR. NUMEL .GT. 200) GO TO 260} \hfill \textbf{EPREP1 149}
\textbf{IF (NUMAF .LE. 1 .OR. NUMAF .GT. 40) GO TO 270} \hfill \textbf{EPREP1 150}

C \textbf{IF THE SYSTEM OF UNITS IS METRIC, CONVERT THE GRAVITATIONAL} \hfill \textbf{EPREP1 151}
C \textbf{CONSTANT TO METRIC UNITS} \hfill \textbf{EPREP1 152}
IF (UNITS .EQ. 6) \hfill \textbf{MAY13 18}
\textbf{C PUT THE VALUES OF THE ANALYSIS FREQUENCIES IN THE FREQUENCY TABLE} \hfill \textbf{EPREP1 153}
\textbf{DO 10 I = 1,NUMAF} \hfill \textbf{EPREP1 154}
\textbf{FTAB(I) = FTAH(I) * FREQ1} \hfill \textbf{EPREP1 155}
\textbf{10 CONTINUE} \hfill \textbf{EPREP1 156}

C \textbf{DO FOR EACH ELEMENT} \hfill \textbf{EPREP1 157}
\textbf{DO 200 I = 1,NUMEL} \hfill \textbf{EPREP1 158}

C \textbf{INCREMENT INPUT} \hfill \textbf{EPREP1 159}
\textbf{INPUT = INPUT + 1} \hfill \textbf{EPREP1 160}

C \textbf{READ THE ELEMENT PROPERTIES} \hfill \textbf{EPREP1 161}
\textbf{READ (12,316,ERR=230) ELNUM,NUMP,ETYPE(I),MYPE(I),} \hfill \textbf{MAY13 19}
\textbf{ETAH(I),SLOPE(I),FREQK(I)} \hfill \textbf{OCT28 4}

C \textbf{WRITE THE ELEMENT PROPERTIES TO OUTPUT} \hfill \textbf{EPREP1 162}
\textbf{WRITE (6,480) INPUT,ELNUM,NUMP,ETYPE(I),MYPE(I),} \hfill \textbf{EPREP1 163}
\textbf{ETAH(I),SLOPE(I),FREQK(I)} \hfill \textbf{NOV3 21}

C \textbf{IF THE ELEMENT NUMBER IS OUT OF ORDER, WRITE A WARNING} \hfill \textbf{EPREP1 164}
\textbf{C MESSAGE} \hfill \textbf{EPREP1 165}
\textbf{IF (ELNUM .EQ. I) GO TO 12} \hfill \textbf{EPREP1 166}
\textbf{WRITE (6,453) INPUT,ELNUM,I} \hfill \textbf{EPREP1 167}
\textbf{12 ELNUM = I} \hfill \textbf{EPREP1 168}

C \textbf{IF THE TYPE OF ELEMENT IS MECHANICAL BUT THE TYPE OF MECHANICAL} \hfill \textbf{EPREP1 169}
\textbf{C INPUT IS NEITHER RMS NOR PSD, WRITE A MESSAGE AND SET THE} \hfill \textbf{EPREP1 170}
C \textbf{ERROR FLAG} \hfill \textbf{EPREP1 171}
\textbf{14 IF (ETYPE(I) .NE. TMT .OR. MYPE(I) .NE. TMT)} \hfill \textbf{EPREP1 172}
\textbf{+ OR . MYPE(I) .EQ. TMT .OR. MYPE(I) = .EQ. TMT .OR.} \hfill \textbf{EPREP1 173}
\textbf{+ MYPE(I) .EQ. TMT .OR. MYPE(I) .EQ. TMT} \hfill \textbf{EPREP1 174}
\textbf{ERFNG = .TRUE.} \hfill \textbf{EPREP1 175}

C \textbf{IF THE TYPE OF EXCITATION IS ACOUSTIC} \hfill \textbf{MAY13 20}
\textbf{15 IF (ETYPE(I) .NE. TMT) GO TO 18} \hfill \textbf{EPREP1 176}

C \textbf{THEN TACRRENT INPUT} \hfill \textbf{EPREP1 177}
\textbf{INPUT1 = INPUT} \hfill \textbf{EPREP1 178}
\textbf{LINES = (NUMAF + 1) / 8} \hfill \textbf{AUG26 317}
\textbf{INPUT = INPUT + LINES} \hfill \textbf{AUG26 32}

C \textbf{ARE READ THE SOUND PRESSURE LEVELS FOR EACH FREQUENCY} \hfill \textbf{EPREP1 180}
\textbf{READ (12,460,ERR=290)END=220) (SPH(I,J),J=1,NUMAF)} \hfill \textbf{MAY13 21}
\textbf{C WRITE THE SOUND PRESSURE LEVELS TO OUTPUT} \hfill \textbf{AUG26 39}
\textbf{WRITE (6,550) INPUT, K, (SPH(I,J),J=1,NUMAF)} \hfill \textbf{AUG26 40}
\textbf{+ J = 1, N), K = 1, LINES} \hfill \textbf{AUG26 41}

C \textbf{ELSE IF THE TYPE OF EXCITATION IS MECHANICAL} \hfill \textbf{EPREP1 182}
\textbf{18 IF (ETYPE(I) .EQ. TMT) GO TO 20} \hfill \textbf{EPREP1 183}

C \textbf{THEN INCREMENT INPUT} \hfill \textbf{EPREP1 184}
\textbf{INPUT1 = INPUT} \hfill \textbf{EPREP1 185}
\textbf{LINES = (NUMAF + 1) / 8} \hfill \textbf{AUG26 42}
284 INPUT = INPUT + LINES
285 C AND READ THE MECHANICAL INPUTS FOR EACH FREQUENCY
286 READ (2,400,ERR=490,END=290) (MECH(M),J=1,NUMF)
287 C WRITE THE MECHANICAL INPUTS TO OUTPUT
288 WRITE (*,550) (INPUT(I) + K, MECH(I), K = (K - 1) * J, J = 1, 8*, K = 1, LINES)
289 C END IF
290 C INITIALIZE MAIN TO SIGNIFY THAT THE FIRST SUB-ELEMENT IS THE
291 MAIN SUB-ELEMENT
292 20 MAIN = .TRUE.
293 25 DO FOR EACH SUB-ELEMENT
295 DO 100 J = 1, NUMSUB
296 C INCREMENT INPUT
297 INPUT = INPUT + 2
298 C READ THE SUB-ELEMENT PROPERTIES
299 READ (*,320,E = ERR=80,END=240) SUBNUM, TYPE, RHO, E,
300 T, a, b, c, d, e, f, g, h, i, j
301 C WRITE THE SUB-ELEMENT PROPERTIES TO OUTPUT
302 WRITE (*,570) INPUT, SUBNUM, TYPE, RHO, E, T, a,
303 b, c, d, e, f, g, h, i, j
304 C CHANGE ALL PLATE, BEAM, CYLINDER, AND MEMBRANE TYPE SUB-
305 ELEMENTS TO THE SAME MODULUS OF ELASTICITY AS THE ELEMENT 1
306 C MAIN SUB-ELEMENT AND SET THEIR THICKNESS SO THAT:
307 10 T = T + (E / E(1)) ** (1./T.1.)
308 IF (EQU(EQ,1)) AND ( Type .NE. 1) .OR.
309 Type .NE. 1 AND ( Type .NE. 101) .OR.
310 Type .NE. 101 AND ( Type .NE. 101) .OR.
311 .EQ. E(E(1)) .EQ. T.C 22
312 T1 = T * (E / E(1)) ** (1./T.3.)
313 RHO = RHO * T / T1
314 T = T1
315 F = E(E(1))
316 22 CONTINUE
317 C IF THE SUB-ELEMENT NUMBER IS OUT OF ORDER, WRITE A WARNING
318 C MESSAGE
319 IF SUBNUM .EQ. J, 80 TO 29
320 WRITE (6,440) INPUT - I, SUBNUM, J
321 C IF THE SUB-ELEMENT IS A BEAM, CALL BEAM
322 25 IF (TYPE .NE. 1) GO TO 20
323 CALL BEAM
324 20 GO TO 100
325 C IF THE SUB-ELEMENT IS A MEMBRANE, CALL MEMBR
326 IF (TYPE .NE. 101) GO TO 40
327 CALL MEMBR
328 40 GO TO 100
329 C IF THE SUB-ELEMENT IS A PLATE, CALL PLATE
330 IF (TYPF .NE. 101) GO TO 50
331 CALL PLATE
332 50 GO TO 100
333 C IF THE SUB-ELEMENT IS A BEAM, CALL BEAM
334 55 IF (TYPE .NE. 101) GO TO 60
335 CALL BEAM
336 60 GO TO 100
337 C IF THE SUB-ELEMENT IS A CYLINDER, CALL CYLIN
338 65 IF (TYPE .NE. 201) GO TO 70
339 CALL CYLIN
340 70 GO TO 100
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340 GO TO 100
341 C ELSE IF THE TYPE OF SUB-ELEMENT IS NONE OF THE ABOVE, WRITE AN
342 C ERROR MESSAGE AND SET THE ERROR FLAG TO TERMINATE THE PROGRAM
343 C ERROR MSGA57 AND SET THE ERROR FLAG TO TERMINATE THE PROGRAM
344 C ERROR = *TRUE*
345 GO TO 100
346 C END IF
347 C IF AN ERROR WAS ENCOUNTERED WHILE READING SUB-ELEMENT PROPERTIES,
348 C WRITE A MESSAGE AND SET THE ERROR FLAG
349 C WRITE (6,540) INPUT-1,INPUT
350 C ERROR = *TRUE*
351 100 CONTINUE
352 GO TO 200
353 C IF AN ERROR WAS ENCOUNTERED WHILE READING ELEMENT PROPERTIES,
354 C WRITE A MESSAGE AND SET THE ERROR FLAG
355 C WRITE (6,550) INPUT
356 C ERROR = *TRUE*
357 GO TO 200
358 C IF AN ERROR WAS ENCOUNTERED WHILE READING SOUND PRESSURE LEVELS,
359 C WRITE A MESSAGE AND SET THE ERROR FLAG
360 C WRITE (6,410) INPUT
361 C ERROR = *TRUE*
362 GO TO 200
363 C IF AN ERROR WAS ENCOUNTERED WHILE READING MECHANICAL INPUTS,
364 C WRITE A MESSAGE AND SET THE ERROR FLAG
365 C WRITE (6,470) INPUT
366 C ERROR = *TRUE*
367 GO TO 200
368 200 CONTINUE
369 DO 207 K = 1, NUMEL+4
370 KPLUS3 = MIN(NUMEL, K + 3)
371 WRITE (6,500) (I, I = K,KPLUS3)
372 DO 207 J2 = 1, NUMAF
373 WRITE(6,510) FTAB(J2),(K(J,J2),J = K,KPLUS3)
374 207 CONTINUE
375 IF (ERROR) RETURN 1
376 RETURN
377 C IF AN ERROR OCCURRED WHILE READING THE FIRST INPUT RECORD,
378 C WRITE A MESSAGE AND SET THE ERROR FLAG
379 210 WRITE (6,560)
380 GO TO 280
381 C IF AN END OF FILE WAS ENCOUNTERED WHILE TRYING TO READ THE
382 C FIRST INPUT RECORD, WRITE A MESSAGE AND SET THE ERROR FLAG
383 220 WRITE (6,570)
384 GO TO 280
385 C IF AN END OF FILE WAS ENCOUNTERED WHILE READING ELEMENT PROPERTIES,
386 C WRITE A MESSAGE AND SET THE ERROR FLAG
387 230 WRITE (6,580) INPUT
388 GO TO 280
389 C IF AN END OF FILE WAS ENCOUNTERED WHILE READING SUB-ELEMENT
390 C PROPERTIES, WRITE A MESSAGE AND SET THE ERROR FLAG
391 240 WRITE (6,590) INPUT
392 GO TO 280
393 C IF AN END OF FILE WAS ENCOUNTERED WHILE READING SOUND PRESSURE
394 C LEVELS, WRITE A MESSAGE AND SET THE ERROR FLAG
395 250 WRITE (6,620) INPUT
396 C PROP222
397 C PROP223
398 C PROP224
399 C PROP225
400 C PROP226
401 C PROP227
402 C PROP228
403 C PROP229
404 C PROP230
405 C PROP231
406 C PROP232
407 C PROP233
408 C PROP234
409 C PROP235
410 C PROP236
411 C PROP237
412 C PROP238
413 C PROP239
414 C PROP240
415 C PROP241
416 C PROP242
417 C PROP243
418 C PROP244
419 C PROP245
420 C PROP246
421 C PROP247
422 C PROP248
423 C PROP249
424 C PROP250
425 C PROP251
426 C PROP252
427 C PROP253
428 C PROP254
429 C PROP255
430 C PROP256
431 C PROP257
432 C PROP258
433 C PROP259
434 C PROP260
435 C PROP261
436 C PROP262
437 C PROP263
438 C PROP264
439 C PROP265
440 C PROP266
441 C PROP267
442 C PROP268
443 C PROP269
444 C PROP270
445 C PROP271
446 C PROP272
447 C PROP273
448 C PROP274
449 C PROP275
450 C PROP276
451 C PROP277
452 C PROP278
453 C PROP279
GO TO 285
C IF THE NUMBER OF ELEMENTS IS OUT OF RANGE, WRITE A
C MESSAGE AND SET THE ERROR FLAG
260 WRITE (6,440) NUMEL
GO TO 295
C IF THE NUMBER OF ANALYSIS FREQUENCIES IS OUT OF RANGE, WRITE A
C MESSAGE AND SET THE ERROR FLAG
210 WRITE (6,460) NUMAF
GO TO 295
C IF AN END OF FILE WAS ENCOUNTERED WHILE READING MECHANICAL
C IMPLIS, WRITE A MESSAGE AND SET THE ERROR FLAG
280 WRITE (6,480) INPUT
285 ERROR = .TRUE.
RETURN 1
ENC
C THIS SUBROUTINE CALCULATES THE MODAL DENSITY FOR A SUB-ELEMENT
C WHICH IS A BEAM AND SUMS THIS VALUE TO THE ELEMENT MODAL
C DENSITY. PFM IS CALLED FROM EPROP.
C
C THE FOLLOWING VARIABLES ARE USED IN THIS PROGRAM UNIT:
C NAME TYPE DESCRIPTION
C ---- ---- ---------------
C A REAL SUB-ELEMENT AREA
C AREA(20) REAL ELEMENT AREA
C C REAL SPEED OF SOUND IN SUB-ELEMENT ROOM MEDIUM
C DENSE(20) REAL ELEMENT DENSITY
C C REAL SUB-ELEMENT MODULUS OF ELASTICITY
C DENSE(20) REAL ELEMENT MODULUS OF ELASTICITY
C FC(20) REAL SPEED OF SOUND IN ELEMENT ROOM MEDIUM
C FEE(20) REAL ELEMENT MODULUS OF ELASTICITY
C G1 REAL POISSON'S RATIO FOR ELEMENT
C ELMN INT ELEMENT NUMBER
C FTA REAL TABLE OF ANALYSES FREQUENCIES
C GAMMA REAL POISSON'S RATIO FOR SUB-ELEMENT
C G4 REAL LENGTH
C M REAL SUB-ELEMENT MODAL MASS (NON-STRUCTURAL)
C PASS REAL SUB-ELEMENT TOTAL MASS
C N(20,40) REAL ELEMENT MODAL DENSITY
C NUF INT NUMBER OF ANALYSIS FREQUENCIES
C OMEGA REAL 2*PI*FREQUENCY
C PSUBPD REAL PARTIAL SUB-ELEMENT MODAL DENSITY
C Q REAL RADIX
C RHO REAL SUB-ELEMENT DENSITY
C S REAL PRESSURE
C SUBPD REAL SUB-ELEMENT MODAL DENSITY
C T REAL SUB-ELEMENT THICKNESS
C THICK(20) REAL ELEMENT THICKNESS
C V REAL SUB-ELEMENT VOLUME
C VOL(20) REAL ELEMENT VOLUME
C
C THE FOLLOWING COMMON BLOCKS ARE USED:
C BLOCK OTHER PROGRAM UNITS USING THIS COMMON BLOCK
C ---- ---------------
C CP1 MAIN, EPROP, MEBPD, PLATE, ROD, CYL, RITER, BLOCK DATA
C CBR EPROP, NEPP, PLATE, ROD, CYL
C CBS EPROP, MEBPD, PLATE, ROD, CYL, JPROP, EXCITE, ANSWER
C CHI EPROP, MEBPD, PLATE, ROD, CYL, JPROP, EXCITE, BLOCK DATA
C CBI MEM, PLATE, ROD, CYL, ANSWER, BLOCK DATA
C
C INTEGER ELMN
C REAL MALL, PASS, PSUR
C LOGICAL STIFF, MAIN
C COMMON /CBS/ ELMN, YF, GAMMA, PHOO, PROP, EXCITE, MAIN
C COMMON /CRA/ AREA(20), DENSE(20), VOL(20), FEE(20),
C COMMON /CRI/ THICK(20), AREA(20), DENSE(20), VOL(20), EEE(20),
C COMMON /CB1/ FTA(40), NUF, FREQ
C COMMON /CB2/ MAIN, EPROP, MEBPD, PLATE, ROD, CYL, RITER, BLOCK DATA
C COMMON /CB3/ EPROP, NEPP, PLATE, ROD, CYL
C COMMON /CB4/ EPROP, MEBPD, PLATE, ROD, CYL, JPROP, EXCITE, ANSWER
C COMMON /CB5/ EPROP, MEBPD, PLATE, ROD, CYL, JPROP, EXCITE, BLOCK DATA
C COMMON /CB6/ MEM, PLATE, ROD, CYL, ANSWER, BLOCK DATA
C
C DATA PI /3.1415927/
C CALCULATE THE PART OF THE SUB-ELEMENT MODAL DENSITY THAT IS
C NOT FREQUENCY DEPENDENT
FSLHPD = L / (2. * PI) * SQRT(SCRT(12., RHO / E) / T)
C IF STIFFNESS REDUCTION IS REQUIRED, MULTIPLY BY SQRT(.5)
IF (STIFF) PSUBMD = SQRT(.5) * PSUBMD
C DO FOR EACH ANALYSIS FREQUENCY
C 20 I = 1,NUMAF
OMEGA = 2. * PI * FIAB[I]
C CALCULATE THE SUB-ELEMENT MODAL DENSITY
SUBMD = PSUBMD / SQRT(OMEGA)
C SUM THE SUB-ELEMENT MODAL DENSITY TO THE ELEMENT MODAL DENSITY
N(ELEMENT[I]) = N(ELEMENT[I]) + SUBMD
20 CONTINUE
C SUM THE SUB-ELEMENT MASS TO THE ELEMENT MASS
PSLA = RHO * A * L * M
PSX(ELEMENT[I]) = PSX(ELEMENT[I]) + PSLA
C IF THIS IS NOT THE MAIN SUB-ELEMENT, RETURN TO EPREP
C IF (.NOT. PAIN) RETURN
C ELSE PLT THE VALUES OF THE FOLLOWING SUB-ELEMENT VARIABLES INTO
C THE CORRESPONDING ELEMENT ARRAYS
EE(ELEMENT[I]) = E
THICK(ELEMENT[I]) = T
DEASE(ELEMENT[I]) = RHO
DEAE(ELEMENT[I]) = A
NC(ELEMENT[I]) = V
EGAMMA(ELEMENT[I]) = GAMMA
EG(ELEMENT[I]) = C
C SET PAIN TO INDICATE THAT ANY FOLLOWING SUB-ELEMENTS ARE NOT
C THE PAIN SUB-ELEMENT
PAIN = .FALSE.
RETURN
END
SUBROUTINE FEMR

C THIS SUBROUTINE CALCULATES THE MODAL DENSITY FOR A SUB-ELEMENT
C WHICH IS A MEMBRANE ANG STRIPS THIS VALUE TO THE ELEMENT MODAL
C DENSITY.  FEMR IS CALLED FROM EPRO.

C THE FOLLOWING VARIABLES ARE USED IN THIS PROGRAM UNIT:

C NAME TYPE DESCRIPTION

C A REAL SUB-ELEMENT AREA
C AREA(20) REAL ELEMENT AREA
C C REAL SPEED OF SOUND IN SUB-ELEMENT ROOM MEDIUM
C DENSE(20) REAL ELEMENT DENSITY
C E REAL SUB-ELEMENT MODULUS OF ELASTICITY
C EC(20) REAL SPEED OF SOUND IN ELEMENT ROOM MEDIUM
C EE(20) REAL ELEMENT MODULUS OF ELASTICITY
C EGA(1,20) REAL POTSSNTS RATIO FOR ELEMENT
C ELNZP INT ELEMENT NUMBER
C FTAH(40) REAL TABLE OF ANALYSIS FREQUENCIES
C GAPPA REAL POTSSNTS RATIO FOR SUB-ELEMENT
C L REAL ELEMENT LENGTH
C M REAL SUB-ELEMENT Added Mass (Non-Structural)
C MASS(20) REAL ELEMENT MASS
C MSUB REAL SUB-ELEMENT TOTAL MASS
C N(20,10) REAL ELEMENT MODAL DENSITY
C NUMAF INT NUMBER OF ANALYSIS FREQUENCIES
C OMF REAL 2*PI*FREQUENCY
C PSNAPB REAL PARTIAL SUB-ELEMENT MODAL DENSITY
C R REAL RADIUS
C RHO REAL SUB-ELEMENT DENSITY
C S REAL PRESSURE
C SUBD REAL SUB-ELEMENT MODAL DENSITY
C T REAL SUB-ELEMENT THICKNESS
C THICK(20) REAL ELEMENT THICKNESS
C V REAL SUB-ELEMENT VOLUME
C VOL(20) REAL ELEMENT VOLUME

C THE FOLLOWING COMMON BLOCKS ARE USED:

C OTHER PROGRAM UNITS USING THIS COMMON BLOCK

INTEGER ELMN
REAL NE, NM, MAS, MSUB
LOGICAL STIFF, MAIN
COMMON /CB1/ FTAH(10), ALMAF, FREG
COMMON /CB5/ THICK(20), AREA(20), DENSE(20), VOL(20), ECM(20)
COMMON /CB6/ GAMMA(20), EEC(20)
COMMON /CB9/ N(20, 40)
COMMON /CB11/ FTAH(20)
C DATA PL/3.1415926
C CALCULATE THE DEPART OF THE SUB-ELEMENT MODAL DENSITY THAT IS
C NOT FREQUENCY DEPENDENT
FSUMO = A * RHO * T / (2. * PI * 5)
C IF STIFFNESS REDUCTION IS REQUIRED, MULTIPLY BY SORT(4,5)
IF (STIFF) FSUMO = SORT(4,5) * FSUPPC
C DO FOR EACH ANALYSIS FREQUENCY
DO 20 T = 1, NUMAF
  OMEGA = 2. * PI * FTAB(I)
C CALCULATE THE SUB-ELEMENT MODAL DENSITY
SUBRD = FSUMO * OMEGA
C SUM THE SUB-ELEMENT MODAL DENSITY TO THE ELEMENT MODAL DENSITY
NELNUM(I) = NELNUM(I) + SUBRD
20 CONTINUE
C SUM THE SUB-ELEMENT MASS TO THE ELEMENT MASS
PSUM = RHO * A * T * M
MSUM(ELEMNUM) = MSUM(ELEMNUM) + PSUM
C IF THIS IS NOT THE MAIN SUB-ELEMENT, RETURN TO EPROP
IF (.NOT. PAIN) RETURN
C ELSE PUT THE VALUES OF THE FOLLOWING SUB-ELEMENT VARIABLES INTO
C THE CORRESPONDING ELEMENT ARRAYS
T(ELEMNUM) = T
THICK(ELEMNUM) = T
DENS(ELEMNUM) = RHO
AREA(ELEMNUM) = A
VOL(ELEMNUM) = V
E(index(ELEMNUM)) = GAMMA
EINDEX(ELEMNUM) = C
C SET PAIN TO INDICATE THAT ANY FOLLOWING SUB-ELEMENTS ARE NOT
C THE MAIN SUB-ELEMENT
PAIN = -.FALSE.
RETURN
END
SUBROUTINE PLATE

C THIS SUBROUTINE CALCULATES THE MODAL DENSITY FOR A SUR-FELMENT
C WHICH IS A PLATE AND SAVES THIS VALUE TO THE ELEMENT MODAL
C DENSITY. PLATE IS CALLED FROM EPROP.
C
C THE FOLLOWING VARIABLES ARE USED IN THIS PROGRAM UNIT:
C NAME TYPE DESCRIPTION
C ___________ ____________ ____________
C A REAL SUB-ELEMENT AREA
C ANP(20) REAL AREA * MODES / MASS OF SURFACE EXCITED BY
C ACoustIC FIELD
C AREA(20) REAL ELEMENT AREA
C C REAL SPEED OF SOUND IN SUB-ELEMENT ROOM MEDIUM
C DEASE(20) REAL ELEMENT DENSITY
C E REAL SUB-ELEMENT MODULUS OF ELASTICITY
C ECC(20) REAL SPEED OF SOUND IN ELEMENT ROOM MEDIUM
C E(20) REAL ELEMENT MODULUS OF ELASTICITY
C E(20) REAL POISSON'S RATIO FOR ELEMENT
C FLAP INT ELEMENT NUMBER
C FTA(40) REAL TABLE OF ANALYSIS FREQUENCIES
C GAMMA REAL POISSON'S RATIO FOR SUB-ELEMENT
C L REAL LENGTH
C M REAL SUB-ELEMENT ADDED MASS (NON-STRUCTURAL)
C MASS(20) REAL ELEMENT MASS
C MSUR REAL SUB-ELEMENT TOTAL MASS
C M2G(40) REAL ELEMENT MODAL DENSITY
C N2F INT NUMBER OF ANALYSIS FREQUENCIES
C N4F REAL 2PI/FREQUENCY
C PSURF REAL PARTIAL SUB-ELEMENT MODAL DENSITY
C R REAL RADIUS
C RPC REAL SUR-FELMENT DENSITY
C S REAL PRESSURE
C SUBNO REAL SUB- ELEMENT MODAL DENSITY
C T REAL SUB-ELEMENT THICKNESS
C THICK(20) REAL ELEMENT THICKNESS
C V REAL SUB-ELEMENT VOLUME
C VOL(20) REAL ELEMENT VOLUME
C
C THE FOLLOWING COMMON BLOCKS ARE USED:
C COMMON /CPI, FTA, ANP, GAMMA, RANC, RCON, CTP, CF1/CMONF, SMONF, M4G, FRED
C COMMON /CPI, FLAP, T, E, GAMMA, RANC, RCON, CTP, CF1/CMONF, SMONF, M4G, FRED

CHARACTER ETYP, TYP,*
REAL M, L, M2G, MSUR
LOGICAL STFF, MAIN
COMMON /CPI, FTA, ANP, GAMMA, RANC, RCON, CTP, CF1/CMONF, SMONF, M4G, FRED
COMMON /CPI, FLAP, T, E, GAMMA, RANC, RCON, CTP, CF1/CMONF, SMONF, M4G, FRED

PLATE 2
PLATE 3
PLATE 4
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PLATE 49
PLATE 50
PLATE 51
PLATE 52
SUBROUTINE PLATE

COMMON /CHEF/, THICK(20), AREA(20), JENSF(20), VOL(20), FE(20),
         ELMNAH(20), ELC(20),
COMMON /CHEF/ , SPL(10), MECH(20,40), ANM(20), ETYPE(20), HTYPE(20)
COMMON /CHEF/ , N(20,40),
COMMON /CHEF/ , M(20,40),
COMMON /CHEF/ , PI(3,159%),

C CALCULATE THE SUP-ELEMENT MODAL DENSITY
C SUPMD = A / (EI * FI) * SORT(12) * RHO * (1. - GAMMA ** 2)
+ / (E * T ** 2)
C IF STIFFNESS REDUCTION IS REQUIRED, MULTIPLY BY SORT(5)
IF (STIF < SUPMD = SORT(5) * SUPMD)
C DO FOR EACH ANALYSIS FREQUENCY
DO 20 I = 1,NUMFL
C SUM THE SUB-ELEMENT MODAL DENSITY TO THE ELEMENT MODAL DENSITY
N(ELEMNUM) = N(ELEMNUM) + SUPMD
20 CONTINUE

C SUM THE SUB-ELEMENT MASS TO THE ELEMENT MASS
MSLH = RHO * A * T * M
i = 0(ELEMNUM) = i = 0(ELEMNUM) + MSLH
IF (ETYPE(ELEMNUM) .EQ. TAT .AND. MAIN) ANM(ELEMNUM) =
C IF THIS IS NOT THE MAIN SUB-ELEMENT, RETURN TO EPREP
IF (.NOT. MAIN) RETURN

C ELSE PUT THE VALUES OF THE FOLLOWING SUB-ELEMENT VARIABLES INTO
C THE CORRESPONDING ELEMENT ARRAYS
C(ELEMNUM) = E
C(MEMNUM) = T
C(MEMNUM) = T
DEMSF(ELEMNUM) = RHO
AREA(ELEMNUM) = A
VOL(ELEMNUM) = V
DEMSF(ELEMNUM) = GAMMA
C(ELEMNUM) = C
C SET MAIN TO INDICATE THAT ANY FOLLOWING SUB-ELEMENTS ARE NOT
C THE MAIN SUB-ELEMENT
MAIN = .FALSE.
RETURN
END
C THIS SUBROUTINE CALCULATES THE MODAL DENSITY FOR A SUB-ELEMENT.
C WHICH IS A RATA AND SUM THIS VALUE TO THE ELEMENT MODAL
C DENSITY. ROOM 4 IS CALLED FIRST.
C
C THE FOLLOWING VARIABLES ARE USED IN THIS PROGRAM UNIT:
C
C NAME TYPE DESCRIPTION
C ------- ------- -------
C A REAL SUB-ELEMENT AREA
C AREA(20) REAL ELEMENT AREA
C C REAL SPEED OF SOUND IN SUB-ELEMENT ROOM MEDIUM
C DENS(20) REAL ELEMENT DENSITY
C E REAL SUB-ELEMENT MODULUS OF ELASTICITY
C EC(20) REAL SPEED OF SOUND IN ELEMENT ROOM MEDIUM
C EEE(20) REAL ELEMENT MODULUS OF ELASTICITY
C FGAPP(20) REAL POISSON'S RATIO FOR ELEMENT
C ELNPM INT ELEMENT NUMBER
C FTAR(40) REAL TABLE OF ANALYSIS FREQUENCIES
C GAAP REAL POISSON'S RATIO FOR SUB-ELEMENT
C G REAL LENGTH
C H REAL SUB-ELEMENT ADDED MASS (NON-STRUCTURAL)
C MASS(20) REAL ELEMENT MASS
C NSUB REAL SUB-ELEMENT TOTAL MASS
C NE(20,40) REAL ELEMENT DENSITY
C NUMAF INT NUMBER OF ANALYSIS FREQUENCIES
C OMEGA REAL 2*PI*FREQUENCY
C PSLHDQ REAL PARTIAL SUB-ELEMENT MODAL DENSITY
C R REAL RADIUS
C RMC REAL SUB-ELEMENT DENSITY
C S REAL PRESSURE
C SUBC REAL SUB-ELEMENT MODAL DENSITY
C T REAL SUB-ELEMENT THICKNESS
C TIDX(20) REAL ELEMENT THICKNESS
C V REAL SUB-ELEMENT VOLUME
C VOL(20) REAL ELEMENT VOLUME
C
C THE FOLLOWING COMMON BLOCKS ARE USED:
C B - OTHER PROGRAM UNITS USING THIS COMMON BLOCK
C
C COMMON /CR1/ KF1B400, MUMAF, FREC
C COMMON /CRM/ FLNM1, SPAN, RHO, STIFF, MAIN
C COMMON /CMWM/ FMNC, THICK(20), AREA(20), DENS(20), VOL(20), EE(20)
C COMMON /CRAM/ 200, 400
C COMMON /CRM/ KF1B400, MUMAF, FREC
C
C CALCULATE THE PART OF THE SUB-ELEMENT MODAL DENSITY THAT IS
MODFREQUENCY DEPENDENT
FS.RPD = V / (2. * PI ** 2 * C ** 4)
DO 2C I = 1, NUMAF
     OMEGA = 2. * PI * FI(I) + 3
     C XCALCULATE THE SUB-ELEMENT MODAL DENSITY
     SUBRD = OMEGA ** 2 * FS.RPD
     C SUM THE SUB-ELEMENT MODAL DENSITY TO THE ELEMENT MODAL
     DENSITY
     MIE(NELNUM(I), NIELNUM(I), I) + SUBRD
   2C CONTINUE
C SUM THE SUB-ELEMENT MASS TO THE ELEMENT MASS
MSUM = PMHO * V
MASS(LNUP) = MASS(LNUP) + MSUM
C IF THIS IS NOT THE MAIN SUB-ELEMENT, RETURN FYHOP
IF (.NOT. MAIN) RETURN
C ELSE PUT THE VALUES OF THE FOLLOWING SUB-ELEMENT VARIABLES INTO
C THE CORRESPONDING ELEMENT ARRAYS
F(X) = F
THICK(LNUP) = T
DENSE(LNUP) = NHO
ANE(LNUP) = A
VCL(LNUP) = V
GAMMA(LNUP) = GAMMA
EC(LNUP) = Z
C SET MAIN TO INDICATE THAT ANY FOLLOWING SUB-ELEMENTS ARE NOT
C THE MAIN SUB-ELEMENT
MAIN = .FALSE.
RETURN
END
SUBROUTINE CYLIN

C THIS SUBROUTUNE CALCULATES THE MODAL DENSITY FOR A SUB-ELEMENT
C WHICH IS A CYLINDER AND SAVES THIS VALUE TO THE ELEMENT MODAL
C DENSITY. CYLIN IS CALLED FROM EPROPF.
C
C THE FOLLOWING VARIABLES ARE USED IN THIS PROGRAM UNIT:

C NAME TYPE DESCRIPTION
C _______ _______ ____________
C A REAL SUB-ELEMENT AREA
C AREA(20) REAL ELEMENT AREA
C C REAL SPEED OF SOUND IN SUB-ELEMENT ROOM MEDIUM
C DENSES(20) REAL ELEMENT DENSITY
C E REAL SUB-ELEMENT MODULUS OF ELASTICITY
C E1(20) REAL SPEED OF SOUND IN ELEMENT ROOM MEDIUM
C E2(20) REAL ELEMENT MODULUS OF ELASTICITY
C EGAMMA(20) REAL POISSON'S RATIO FOR ELEMENT
C ELNUM INT ELEMENT NUMBER
C FTARE(40) REAL TABLE OF ANALYSIS FREQUENCIES
C GAPPA REAL POISSONS RATIO FOR SUB-ELEMENT
C L REAL LENGTH
C M REAL SUB-ELEMENT ADDED MASS (NON-STRUCTURAL)
C MASE(20) REAL ELEMENT MASS
C PSUB REAL SUB-ELEMENT TOTAL MASS
C WGE(40) REAL ELEMENT MODAL DENSITY
C NUMAF INT NUMBER OF ANALYSIS FREQUENCIES
C OMEGA REAL 2*PI*FREQUENCY
C PSUPD REAL PARTIAL SUB-ELEMENT MODAL DENSITY
C R REAL RADIUS
C ROH REAL SUB-ELEMENT DENSITY
C S REAL PRESSURE
C SUBPD REAL SUB-ELEMENT MODAL DENSITY
C T REAL SUB-ELEMENT THICKNESS
C THICK(20) REAL ELEMENT THICKNESS
C V REAL SUB-ELEMENT VOLUME
C WCL(20) REAL ELEMENT VOLUME
C
C THE FOLLOWING COMMON BLOCKS ARE USED:
C BLOCK OTHER PROGRAM UNITS USING THIS COMMON BLOCK
C
C COMMON /CR1/ FTARE(40),NUMAF,PSUPD
C COMMON /CB1/ MASE(20),EPROP,EBEAM,EMEM,PLATE,RITERS,BLOCK DATA
C COMMON /CB4/ EPROP,EBEAM,EMEM,PLATE,RITERS,BLOCK DATA
C COMMON /CB5/ EPROPF,EBEAM,EMEM,PLATE,RITERS,BLOCK DATA
C COMMON /CB11/ EPROPF,EBEAM,EMEM,PLATE,RITERS,BLOCK DATA
C COMMON /CR11/ MASS(40)

C INTEGRA CYLIN
C
C REAL MASE,MASUM,MAIN
C LOGICAL STIFF,MAIN
C COMMON /CR1/ FTARE(40),NUMAF,PSUPD
C COMMON /CB1/ MASE(20),EPROP,EBEAM,EMEM,PLATE,RITERS,BLOCK DATA
C COMMON /CB4/ EPROP,EBEAM,EMEM,PLATE,RITERS,BLOCK DATA
C COMMON /CB5/ EPROPF,EBEAM,EMEM,PLATE,RITERS,BLOCK DATA
C COMMON /CB11/ EPROPF,EBEAM,EMEM,PLATE,RITERS,BLOCK DATA
C COMMON /CR11/ MASS(40)

C
**SUBROUTINE CYLIN**

```
A25  DATA PI /3.1415927/
A26  C CALCULATE THE PART OF THE SUB-ELEMENT MODAL DENSITY THAT IS
A27  C NOT FREQUENCY DEPENDENT
A28  F = SUBMOD * R / L / 2. * SQRT(12. * R / C) *
A29  * (1. - GAMMA ** 2) / (C / T ** 2))
A30  IF (STIFF) PSUBMO = SQRT(SGAM) * FSUBMC
A32  DO FOR EACH ANALYSIS FREQUENCY
A33  DC 20 I = 1,NUMAF
A34  SUBMO = FSUBMC
A35  OPFRA = 2. * PI * F(ITRI)
A36  C CALCULATE THE CRITERION FOR THE FREQUENCY DEPENDENT PART
A37  C OF THE SUB-ELEMENT MODAL DENSITY
A39  CRIT = OMEGA * R / SQRT(PSMB / E)
A40  C IF THE CRITERION IS GREATER THAN 1, ALTER THE MODAL DENSITY
A41  C APPROPRIATELY
A41  IF (CRIT > 1.0) SUBMO = SUBMO * CRIT ** (2.*3.)*
A42  C SLW THE SUB-ELEMENT MODAL DENSITY TO THE ELEMENT MODAL DENSITY
A43  N(E[NUM], I) = N(E[LNUP], I) + SUBMO
A44  ZE CONTINUE
A45  C SUM THE SUB-ELEMENT MASS TO THE ELEMENT MASS
A46  A = 2. * PI * R * L
A47  MSLB = A * T * QRH * M
A48  MASEL(NUM) = MASEL(NUM) + MSLB
A49  C IF THIS IS NOT THE MAIN SUB-ELEMENT, RETURN TO EPREF
A50  IF (.NOT. PAIN) RETURN
A51  C ELSE PUT THE VALUES OF THE FOLLOWING SUB-ELEMENT VARIABLES INTO
A52  C THE CORRESPONDING ELEMENT ARRAYS
A53  EE[L(NUM)] = E
A54  THIC[L(NUM)] = T
A55  CENS[L(NUM)] = RHO
A56  ARE[L(NUM)] = A
A57  VOLS[L(NUM)] = V
A58  ESAMM[L(NUM)] = GAMMA
A59  ECC[L(NUM)] = C
A60  C SET PAIN TO INDICATE THAT ANY FOLLOWING SUB-ELEMENTS ARE NOT
A61  C THE MAIN SUB-ELEMENT
A62  PAIN = .FALSE.
A63  RETURN
A64  END
```
SUBROUTINE JINPUT

C THIS SUBROUTINE READS JOINT PROPERTIES FROM UNIT 3 AND CHECKS
C THAT ELEMENT PAIRS ARE NOT INPUT MORE THAN ONCE.  JINPUT IS
C CALLED FROM THE MAIN PROGRAM.

C THE FOLLOWING VARIABLES ARE USED IN THIS PROGRAM UNIT:

C NAME    DESCRIPTION
C ------    --------
C C       JINPUT 0
C ASD(150) REAL  ACOUSTIC SPACE DENSITY
C RL(150)  REAL  REAM LENGTH
C INPLT    INT    NUMBER OF INPUT RECORDS READ
C JL(190)  REAL  JOINT LENGTH
C JTYPE(190) CHAR  TYPE OF JOINT
C NE1(150) INT    FIRST ELEMENT
C NE2(190) INT    SECOND ELEMENT
C NS(190)  INT    NUMBER OF SIDES
C NPEL    INT    NUMBER OF ELEMENTS
C SE(150)  REAL  PLOT SPACING
C TL(190)  REAL  THICKNESS OF FIRST ELEMENT OF PAIR
C TT(190)  REAL  THICKNESS OF SECOND ELEMENT OF PAIR
C TPL(190) INT    TOTAL NUMBER OF ELEMENT PAIRS INPUT

C THE FOLLOWING COMMON BLOCKS ARE USED:

C BLOCK OTHER PROGRAM UNITS USING THIS COMMON BLOCK

C -----    ----------
C CB2    EPROP,BLOCK DATA
C CH7    EPROP,APROP,EXCITE,ANSWER,SOLVE,ITER,BLOCK DATA
C CB10   EPROP,BLOCK DATA
C CP12   JPROP

C CHARACTER#2 JTYPE
C INTEGER TOTAL
C REAL JL

C LOGICAL ERROR

C COMMON /CB2/ ERROR
C COMMON /CH7/ NPEL
C COMMON /CB10/ INP
C COMMON /CP12/ JPROP
C COMMON /JL/ JTYPE(190)
C COMMON /CH7/ NL(190),NE1(190),NE2(190),RL(190),INPLT(190),TOTAL
C
C 180 FORMAT (12I5,1X,6F10.2)
C
C 110 FORMAT (18*** WARNING *** ON INPUT RECORD #,14,1, ONE OR
C 1     BOTH MEMBERS OF THE #1 ELEMENT PAIR T,12,1 AND T,12,2
C 1     WAS EITHER LESS THAN 1 OR GREATER THAN 10.  THE #1
C 1     TOTAL NUMBER OF ELEMENTS THIS FAIR WILL BE IGNORED.  #1
C 1     THIS ERROR WAS DISCOVERED BY SUBROUTINE JINPUT.)
C
C 120 FORMAT (18*** WARNING *** THE ELEMENT PAIR #12,1 AND #12,2
C 1     ON INPUT RECORD #,14,1, WAS NOT PREVIOUSLY READ ON #12,2
C 1     THE FIRST VALUES WILL BE USED. #1
C 1     THIS ERROR WAS DISCOVERED BY SUBROUTINE JINPUT.)
C
C 130 FORMAT (18*** ERROR *** WHILE ATTEMPTING TO READ JOINT #
C 1     1 EPROPTIES,14,1 A FORTRAN ERROR OCCURRED ON INPUT RECORD #
C 1     #1
C 1     THIS ERROR WAS DISCOVERED BY SUBROUTINE JINPUT.)

MAY 3 49
JINPUT 3
JINPUT 4
JINPUT 5
JINPUT 6
JINPUT 7
JINPUT 8
JINPUT 9
JINPUT 10
AUG 12 4
JINPUT 11
JINPUT 12
JINPUT 13
JINPUT 14
JINPUT 15
JINPUT 16
JINPUT 17
JINPUT 18
JINPUT 19
JINPUT 20
JINPUT 21
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JINPUT 32
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JINPUT 36
JINPUT 37
JINPUT 38
JINPUT 39
JINPUT 40
MAY 3 50
JINPUT 41
AUG 12 5
JINPUT 42
JINPUT 43
JINPUT 44
JINPUT 45
JINPUT 46
JINPUT 47
JINPUT 48
JINPUT 49
JINPUT 50
JINPUT 51
JINPUT 52
JINPUT 53
JINPUT 54
JINPUT 55
JINPUT 56
160 FORMAT (10*** ERROR *** THE END OF FILE WAS REACHED BEFORE 1.\n 1 TAPP INFORMATION ABOUT JOINT PROPERTIES WAS READ.**/\n 5 THIS ERROR WAS DISCOVERED BY SUBROUTINE JINPUT.**/\n 4 * WILL ABORT.**/\n 260 FORMAT (10*** WARNING *** ON INPUT RECORD 194,\n 1 BOTH ELEMENT NUMBERS WERE GIVEN AS 1.12,\n 2 THEY MUST BE DIFFERENT. THIS RECORD WILL BE IGNORED.**/\n 259 FORMAT (10*** ERROR WAS DISCOVERED BY SUBROUTINE JINPUT.**/\n 300 FORMAT (10*** WARNING *** ON INPUT RECORD 194,\n 1 T. ELEMENT 1, 12 / 10X, SECOND 1,\n 2 NUMBER OF SIDES = 1, 12 / 10X, TYPE OF JOINT = 1, 12 / 10X,\n 3 JOINT LENGTH = 1, 12 / 10X, THICKNESS OF FIRST ELEMENT = 1,\n 4 JOINT LENGTH = 1, 12 / 10X, THICKNESS OF SECOND ELEMENT = 1,\n 5 1PE12.58 / 10X, ACOUSTIC SPACE DENSITY = 1, 1PE12.58 / 10X,\n 6 10X, TANK LENGTH = 1, 1PE12.58 / 10X, INSERTION LOSS = 1,\n 7 T. FACTOR = 1, 1PE12.58 / 200\n 301 WRITE (4,160) \n 302 C WRITE A HEADING TO CONTINUE PRINTING INPUT DATA \n 303 WRITE (6,160) \n 304 C INITIALIZE TOTAL \n 305 TOTAL = 0 \n 306 C INITIALIZE I \n 307 I = 0 \n 308 C INCREMENT I \n 309 5 i = i + 1 \n 310 C INCREMENT INPUT \n 311 10 INPUT = INPUT + 1 \n 312 C READ THE JOINT PROPERTIES \n 313 READ (5,100,END=60) TNE1(I), TNE2(I), TTYPE(I), TNS(I), TNL(I),\n 314 2 TIE1(I), TIE2(I), TSE(I), TSP(I) \n 315 C WRITE THE JOINT PROPER TO OUTPUT \n 316 WRITE (6,170) TIE1(I), TIE2(I), TNE1(I), TNE2(I), TTYPE(I), TNS(I), TNL(I),\n 317 2 TIE1(I), TIE2(I), TSE(I), TSP(I) \n 318 C PUT THE INPUT RECORD NUMBER IN JPUT \n 319 JPUT(I) = INPUT \n 320 C IF EITHER ELEMENT NUMBER IS OUT OF RANGE, \n 321 IF (TNE1(I) .GE. 1 .AND. TNE2(I) .LE. NUMEL) .OR. (TNE1(I) .GE. 1 .AND. TNE2(I) .GE. 1 .AND. TNE1(I) .LE. NUMEL) GO TO 15 \n 322 C THEN WRITE A WARNING MESSAGE \n 323 WRITE (4,110) INPUT,TNE1(I), TNE2(I), NUMEL \n 324 GO TO 10 \n 325 C END IF \n 326 C IF BOTH ELEMENTS IN THE PAIR ARE THE SAME, \n 327 IF (TNE1(I) .EQ. TNE2(I)) GO TO 20 \n 328 C THEN WRITE A WARNING MESSAGE \n 329 WRITE (4,160) INPUT,TNE1(I) \n 330 GO TO 10 \n 331 C END IF \n 332 C IF THIS IS THE FIRST ELEMENT PAIR, SKIPI THE FOLLOWING TEST \n 333 10 IF (I .LE. 1) GO TO 90 \n 334 C FOR EACH PAIR OF ELEMENTS PREVIOUSLY INPUT \n 335 GO TO 5 \n 336 C IF THE CURRENT PAIR OF ELEMENTS MATCHES A PREVIOUS PAIR, \n 337 IF (TNE1(I) .EQ. TNE1(J) .OR. TNE2(I) .EQ. TNE2(J)) \n 338 20 IF (I .LE. J) GO TO 90 \n 339 C 5 TOTAL \n 340 \n 341
577 IF (AF1(JI), NF, NF2(JI)) OR (AF2(JI), NF, NE1(JI)) GO TO 50
578 C THEN WRITE A WARNING MESSAGE
579 WRITE (6,120) NE1(JI),NE2(JI),INPUT,JPUT(JI)
580 GO TO 10
581 C END IF
582 C CONTINUE
583 C INCREMENT TOTAL
584 50 TOTAL = I
585 GO TO 5
586 C IF AN ERROR OCCURRED ON READING, WRITE AN ERROR MESSAGE
587 60 WRITE (6,130) INPUT
588 ERROR = 'TRUE'
589 GO TO 10
590 C IF THE END OF FILE WAS ENCOUNTERED, PUT NO RECORDS
591 C WERE READ, WRITE A MESSAGE AND SET THE ERROR FLAG
592 70 IF (TOTAL >= 1) GO TO 90
593 ERROR = 'TRUE'
594 WRITE (6,140)
595 C IF THERE WERE NO ERRORS, RETURN
596 80 IF (.NOT. ERROR) RETURN
597 C ELSE WRITE A MESSAGE AND TERMINATE THE PROGRAM
598 WRITE (6,150)
599 CALL ERR
1000 END
<table>
<thead>
<tr>
<th>Line</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1001</td>
<td>SUBROUTINE JPROP</td>
</tr>
<tr>
<td>1002</td>
<td>C THIS SUBROUTINE CALCULATES THE ELEMENT-TC-ELEMENT STRUCTURAL</td>
</tr>
<tr>
<td>1003</td>
<td>COUPLING COEFFICIENT (MT). JPROP IS CALLED FROM THE MAIN</td>
</tr>
<tr>
<td>1004</td>
<td>C PRCRAN.</td>
</tr>
<tr>
<td>1005</td>
<td>C</td>
</tr>
<tr>
<td>1006</td>
<td>C THE FOLLOWING VARIABLES ARE USED IN THIS PROGRAM UNIT:</td>
</tr>
<tr>
<td>1007</td>
<td>C NAME TYPE DESCRIPTION</td>
</tr>
<tr>
<td>1008</td>
<td>C</td>
</tr>
<tr>
<td>1009</td>
<td>C A REAL PSEUDO AREA</td>
</tr>
<tr>
<td>1010</td>
<td>C AF INT ANALYSIS FREQUENCY ORDINAL</td>
</tr>
<tr>
<td>1011</td>
<td>C AREA(20) REAL SURFACE AREA</td>
</tr>
<tr>
<td>1012</td>
<td>C ASC(19) REAL ACOUSTIC SPACE DENSITY</td>
</tr>
<tr>
<td>1013</td>
<td>C BKL(190) REAL BEAM LENGTH</td>
</tr>
<tr>
<td>1014</td>
<td>C CAFREH REAL CRITICAL FREQUENCY</td>
</tr>
<tr>
<td>1015</td>
<td>C CEN(x)(20) REAL DENSITY</td>
</tr>
<tr>
<td>1016</td>
<td>C CIC(20) REAL SPEED OF SOUND IN PCC# MEDIUM</td>
</tr>
<tr>
<td>1017</td>
<td>C CE220 REAL MODULI OF ELASTICITY</td>
</tr>
<tr>
<td>1018</td>
<td>C CEGAPPA(20) REAL POISSON'S RATIO</td>
</tr>
<tr>
<td>1019</td>
<td>C E1 INT FIRST ELEMENT</td>
</tr>
<tr>
<td>1020</td>
<td>C E2 INT SECOND ELEMENT</td>
</tr>
<tr>
<td>1021</td>
<td>C FREQ REAL FREQUENCY</td>
</tr>
<tr>
<td>1022</td>
<td>C JL(190) REAL JOINT LENGTH</td>
</tr>
<tr>
<td>1023</td>
<td>C JTYPE(190) CHAR TYPE OF JOINT</td>
</tr>
<tr>
<td>1024</td>
<td>C NOD(20) REAL NUMBER OF NODES IN BANDWIDTH</td>
</tr>
<tr>
<td>1025</td>
<td>C M(20,40) REAL MODAL DENSITY</td>
</tr>
<tr>
<td>1026</td>
<td>C MEL(190) INT FIRST ELEMENT</td>
</tr>
<tr>
<td>1027</td>
<td>C MEL(190) INT SECOND ELEMENT</td>
</tr>
<tr>
<td>1028</td>
<td>C MEL(190) INT NUMBER OF SIDES</td>
</tr>
<tr>
<td>1029</td>
<td>C ANG REAL 2<em>PI</em>FREQUENCY</td>
</tr>
<tr>
<td>1030</td>
<td>C PMI(20,20) REAL COUPLING COEFFICIENT</td>
</tr>
<tr>
<td>1031</td>
<td>C SIPK(20) REAL RADIATION EFFICIENCY</td>
</tr>
<tr>
<td>1032</td>
<td>C SPK(190) REAL HOLT SPACING REDUCTION</td>
</tr>
<tr>
<td>1033</td>
<td>C TAU REAL THICKNESS RATIO</td>
</tr>
<tr>
<td>1034</td>
<td>C THICK(20) REAL THICKNESS</td>
</tr>
<tr>
<td>1035</td>
<td>C TOTAL INT NUMBER OF ELEMENT PAIRS (1=JOINTS)</td>
</tr>
<tr>
<td>1036</td>
<td>C V(20) REAL VOLUME</td>
</tr>
<tr>
<td>1037</td>
<td>C</td>
</tr>
<tr>
<td>1038</td>
<td>C THE FOLLOWING COMMON BLOCKS ARE USED:</td>
</tr>
<tr>
<td>1039</td>
<td>C</td>
</tr>
<tr>
<td>1040</td>
<td>C BLOCK OTHER PROGRAM UNITS USING THIS COMMON BLOCK</td>
</tr>
<tr>
<td>1041</td>
<td>C</td>
</tr>
<tr>
<td>1042</td>
<td>C CRI MAIN,EXCITE,ANSWER</td>
</tr>
<tr>
<td>1043</td>
<td>C CP FRPR,BEAM,MEPP,PLATE,ROOM,CYLIN,EXCITE,ANSWER</td>
</tr>
<tr>
<td>1044</td>
<td>C CEJ EPRP,INPUT,EXCITE,ANSWER,SOLVER,ITER,BLOCK DATA</td>
</tr>
<tr>
<td>1045</td>
<td>C CHN EPRP,BEAM,MEPP,PLATE,ROOM,CYLIN,EXCITE,BLOCK DATA</td>
</tr>
<tr>
<td>1046</td>
<td>C CHI2 JINPUT</td>
</tr>
<tr>
<td>1047</td>
<td>C CPB4 EXCITE,ANSWER</td>
</tr>
<tr>
<td>1048</td>
<td>C</td>
</tr>
<tr>
<td>1049</td>
<td>C</td>
</tr>
<tr>
<td>1050</td>
<td>C CHARACTER*2 JTYPE</td>
</tr>
<tr>
<td>1051</td>
<td>C INTEGER AF,EL+2,TOTAL</td>
</tr>
<tr>
<td>1052</td>
<td>C REAL JL,A,PODS</td>
</tr>
<tr>
<td>1053</td>
<td>C LOGICAL ERROR</td>
</tr>
<tr>
<td>1054</td>
<td>C COMMON/CRI/MAIN,FREQ,AF,OMEGA</td>
</tr>
<tr>
<td>1055</td>
<td>C COMMON/CPJ/THICK(20),AREA(20),DENST(20),VOL(20),ET(20)</td>
</tr>
<tr>
<td>1056</td>
<td>C E1(20) REAL POCES</td>
</tr>
<tr>
<td>1057</td>
<td>C</td>
</tr>
</tbody>
</table>
SUBROUTINE JPROP

COMMON /CA7/ NUMFLG
COMMON /CBS/ N(20,40)
COMMON /C12/ JTYPE(190)
COMMON /C12/ NEI(190),NE(190),NL(190),NJ(190),OM(190),NPS(190),JPUT(190),TOTAL
COMMON /CB/ PHI(20,20),MODES(20)
COMMON /PI/ ERR(5,1512),FALSE/

200 FORMAT (14,E20.14) THE TYPE OF JOINT GIVEN FOR I,
1 ELEMENT PAIR 1,2,3,4 AND 1,12,13 ON INPUT RECORD 1,4,4,1 IS,
2 A2#1#. THIS IS NOT A VALID TYPE. THE TYPE MUST/
3 BE PP, BP, B+ OR P+/
9 THIS ERROR WAS DISCOVERED BY SUBROUTINE JPROP.

220 FORMAT (because of the errors listed above, thesea program,
3 WILL ABORT.)

C INITIALIZE THE COUPLING COEFFICIENTS TO C AND CALCULATE MODES
DO 20 C = 1, 20
MODES(C) = W(C+1,OM)/4.33
DO 10 I = 1, 20
PHI(I,1) = 0.
10 CONTINUE
20 CONTINUE

C DO FOR EACH PAIR OF ELEMENTS FOR WHICH JOINT PROPERTIES
C WERE INPUT
DO 100 I = 1, TOTAL
C PUT THE ELEMENT NUMBERS IN SIMPLE VARIABLES TO AVOID
C DOUBLE SUBSCRIPTS
E1 = NE1(I)
E2 = NE2(I)
C IF THE TYPE OF JOINT IS PLATE TO PLATE,
10 IF JTYPE(I) .NE. TTPF GO TO 30
C THEN SET TAU TO A/27
C UNLESS THE RATIO OF THICKNESS IS LESS THAN .5, IN WHICH CASE
C SET TAU TO THE RATIO
IF E1(I) .LT. .5
9 TAU = E1(I)/27
109 C CALCULATE THE PSEUDO AREA
A = 2.*PI.*HEX(1,AF) + T1(I) + SORT(E,1) / 12.*DEN(1) + (1. - EGAMMA(1) ** 2))
C CALCULATE THE COUPLING COEFFICIENT FOR PLATE TO PLATE COUPLING
PHI1(E1,E2) = JL(I) / (PI * A * MODES(E2))
E = SORT(OMEGA * THICK(E1)) + S0T(EEE1) / DEN(E1) * 61. - EGAMMA(1) ** 2) * TAU
GO TO 90
10 C ELSE IF TYPE OF JOINT IS REAM TO PLATE,
30 IF JTYPE(I) .NE. TTP GO TO 40
C CALCULATE THE COUPLING COEFFICIENT FOR THAT TYPE
PHI1(E1,E2) = 2.*PI.*FREQ.*JL(I) / (MODES(E2) * 4. * NL(I))
GO TO 90
C ELSE IF THE TYPE OF JOINT IS BOLTED OR RIVETED JOINT,
40 IF JTYPE(I) .NE. TFF Go TO 50
C THEN SET TAU TO A/27
C UNLESS THE RATIO OF THICKNESS IS LESS THAN .5, IN WHICH CASE
C SET TAU TO THE RATIO
JPROP 50
JPROP 50
JPROP 54
MAY 50
JPROP 61
JPROP 56
MAY 56
JPROP 64
JPROP 64
JPROP 64
JPROP 67
JPROP 67
JPROP 68
JPROP 69
JPROP 70
JPROP 74
JPROP 75
JPROP 76
JPROP 77
JPROP 78
JPROP 79
JPROP 80
JPROP 81
JPROP 82
JPROP 83
JPROP 84
JPROP 85
JPROP 86
MAY 61
JPROP 88
JPROP 90
JPROP 93
JPROP 93
JPROP 94
JPROP 95
JPROP 96
JUNE 92
JPROP 98
JPROP 99
JPROP 100
JPROP 101
JPROP 102
JPROP 103
JPROP 104
JPROP 105
JPROP 106
JPROP 109
JPROP 110
JPROP 111
JPROP 112
JPROP 113
JPROP 114
JPROP 115
1113  IF T1(I) / T2(I) .LT. .5)
1114      TAU = T1(I) / T2(I)
1115  C CALCULATE THE PSEUDO AREA
1116      A = .5 * PI * N(EI,AEI) * T(I) * SQRT((E(I) / (E12 * DENS(EI) + (1. - EGAMMA(EI)) ** 2)))
1117  C CALCULATE THE COUPLING COEFFICIENT FOR THAT TYPE
1118      PHIE11(E2) = 1.07 * JL(I) / (PI * A * N(E2)) *
1119         SQRT(OMEGA) * THICK(E1) * SQRT((E(I) / DENS(EI)) * (1. - EGAMMA(EI)) ** 2)) * TAU / SPE
1120  C IF THE TYPE OF JOINT IS PLATE TO ACOUSTIC SPACE,
1121      GO TO 50
1122  C IF (JTYPE(E1) .NE. JTYPE(E2)) GO TO 60
1123  C CALCULATE THE CRITICAL FREQUENCY
1124      CFREQ = E(C(FE)) ** 2 / (1. * THICK(E1))
1125  C CALCULATE THE RADIATION EFFICIENCY USING THE SIGF FUNCTION
1126      SIGMA = 10. ** SIGF(CFREQ / CFREQ)
1127  C CALCULATE THE COUPLING COEFFICIENT FOR THAT TYPE
1128      PHIE11(E2) = 4.33 * PI * E(C(FE)) ** 4 / (CFREQ * DENS(EI))
1129      VOL(E2) = NS(I) * DENS(EI) * THICK(E1)
1130      SIGMA / ASO(I)
1131  C ELSE IF THE TYPE OF JOINT IS NONE OF THE ABOVE, SET THE ERROR
1132  C FILE AND WRITE AN ERROR MESSAGE
1133      60 ERROR = .TRUE.
1134      WRITE (#200) E1,E2,JPUT(I),JTYPE(I)
1135  C END IF
1136      90 PHIE2(E1) = PHIE1(E1,E2)
1137      180 CONTINUE
1138  C IF NO ERRORS IN JOINT TYPE WERE ENCOUNTERED, RETURN
1139      IF (.NOT. ERROR) RETURN
1140  C ELSE WRITE A MESSAGE AND TERMINATE THE PROGRAM
1141      WRITE (#220)
1142      CALL FERR
1143      ENDF
FUNCTION SIGF

1148
1149  FUNCTION SIGF(X)
1150  C THIS FUNCTION SUBPROGRAM RETURNS A VALUE FOR THE RADIATION
1151  C EFFICIENCY OF A PANEL BASED ON THE FOLLOWING TABLE:
1152  C
1153  C      X  SIGF // X  SIGF // X  SIGF // X  SIGF
1154  C
1155  C    --- --- // --- --- // --- --- // --- ---
1156  C    .00 1.8 // .41 1.0 // .17 0.2 // 1.0 0.0
1157  C    .11 1.6 // .50 0.8 // .82 0.0 // 1.5 0.4
1158  C    .22 1.4 // .60 0.6 // .85 0.2 // 1.9 0.2
1159  C    .32 1.2 // .70 0.4 // .92 0.4 // 0.0
1160  C
1161  C THE ENTRY IN THE X COLUMN IS THE MAXIMUM VALUE OF X FOR WHICH
1162  C SIGF HAS THE INDICATED VALUE. SIGF IS CALLED FROM JPROP AND
1163  C EXCITE.
1164  C
1165  C THE FOLLOWING VARIABLES ARE USED IN THIS PROGRAM UNIT:
1166  C
1167  C NAME  TYPE   DESCRIPTION
1168  C
1169  C D(16)   REAL   A TABLE OF VALUES TO COMPARE WITH X
1170  C I      INT    THE ORDINAL OF THE LEAST VALUE OF D GREATER THAN X
1171  C X      REAL   THE RATIO OF THE ANALYSIS FREQUENCY TO THE
1172  C CRITICAL FREQUENCY
1173  C
1174  C
1175  C DIMENSION D(16)
1176  DATA D /0*0,1*1,2*2,3*3,4*4,5*5,6*6,7*7,
1177  1*1,2*2,3*3,4*4,5*5,6*6,7*7/ JUNE2514
1178  C DETERMINE WHERE X LIES IN THE TABLE
1179  DO 20 I = 2, 15
1180  IF (X .LE. D(I)) GO TO 30
1181  20 CONTINUE
1182  I = 16
1183  C SIGF REACHES A MAXIMUM AT I = 13. A DIFFERENT ALGORITHM
1184  C FOR COMPUTING SIGF IS REQUIRED DEPENDING ON WHETHER I IS
1185  C GREATER OR LESS THAN 13.
1186  30 IF (I .LE. 14) GO TO 50
1187  SIGF = -.2  +  .2 * FLOAT(I)
1188  C INTERPOLATE
1189  SIGF = -.2  /  (D(I) - D(I - 1)) * (D(I) - X) + SIGF
1190  RETURN
1191  50 SIGF = -.2  +  .2 * FLOAT(I - 1)
1192  C INTERPOLATE IF X IS LESS THAN 4
1193  IF (X .GE. D(I)) RETURN
1194  SIGF = -.2  /  (D(I) - D(I - 1)) * (D(I) - X) + SIGF
1195  RETURN
1196  ENC
SUBROUTINE EXCITE
C THIS SUBROUTINE DETERMINES ELEMENT ENERGY LEVELS OR ACOUSTIC
C ENERGY INPUTS DEPENDING ON THE TYPE OF EXCITATION. EXCITE IS
C CALLED FROM THE MAIN PROGRAM.

C THE FOLLOWING VARIABLES ARE USED IN THIS PROGRAM UNIT:
1200 C NAME TYPE DESCRIPTION
1201 C ---- ---- -----------
1202 C AF REAL ANALYSIS FREQUENCY OPTIMAL
1203 C ANN(20) REAL AREA + MODES / MASS OF SURFACE EXCITED BY
1204 C ACOUSTIC FIELD
1205 C AREA(20) REAL AREA
1206 C C(20) REAL ELEMENT ENERGY LEVELS
1207 C FC(20) REAL SPEED OF SOUND IN ROOM MEDIUM
1208 C TYPE(20) CHAR TYPE OF EXCITATION
1209 C NCHS REAL NUMBER OF MODES IN BANDWIDTH
1210 C FREQ REAL FREQUENCY
1211 C G REAL GRAVITATIONAL CONSTANT
1212 C PASS(20) REAL MASS
1213 C MECH(240) REAL MECHANICAL INPUT
1214 C TYPE(20) REAL TYPE OF MECHANICAL INPUT
1215 C N(20,40) REAL MODAL DENSITY
1216 C NUMEL INT NUMBER OF ELEMENTS
1217 C OMEGA REAL 2*PI*FREQUENCY
1218 C S(20) REAL ACOUSTIC ENERGY INPUT
1219 C SIGMA(20) REAL RADIATION EFFICIENCY
1220 C SPL(20,40) REAL SOUND PRESSURE LEVELS
1221 C
1222 C THE FOLLOWING COMMON BLOCKS ARE USED:
1223 C BLOCK OTHER PROGRAM UNITS USING THIS COMMON BLOCK
1224 C -------------------------------
1225 C CB1 MAIN,JPROP,ANSWER
1226 C CB5 EPROP,REAR,MEMBR,PLATE,ROOM,CYLIN,JPROP,ANSWER
1227 C CB6 EPROP,PLATE
1228 C CB7 EPROP,INPUT,JPROP,ANSWER,SOLVE,ITER,BLOCK DATA
1229 C CB9 EPROP,REAR,MEMBR,PLATE,ROOM,CYLIN,JPROP,ANSWER,BLOCK DATA
1230 C CB10 REAR,MEMBR,PLATE,ROOM,CYLIN,ANSWER,BLOCK DATA
1231 C CB11 JPROP,ANSWER
1232 C CB12 ANSWER,SOLVE
1233 C
1234 C CHARACTER ETYPE,MTYPE=3
1235 C INTEGER AF
1236 C REAL N, PASS, MODES, MECH
1237 C COMMON /CB3/ AF,OMEGA
1238 C COMMON /CB5/ THICK(20),AREA(20),DENSI(20),VOL(20),EE(20)
1239 C COMMON /CB6/ N(20,40)
1240 C COMMON /CB7/ SPL(20,40)
1241 C COMMON /CB8/ MECH(20,40),ANN(20),ETYPE(20),MTYPE(20)
1242 C COMMON /CB9/ N(20,40)
1243 C COMMON /CB10/ MASS(20)
1244 C COMMON /CB11/ N(20,40)
1245 C COMMON /CB12/ PH(20,20),MODES(20)
1246 C COMMON /CB13/ S(20,20)
1247 C COMMON /CB14/ PI(20,20),SOL(20)
1248 C --- DATA PI,1,1, NUMEL
1249 C FOR EACH ELEMENT
1250 C 0. 100 1 = 1, NUMEL

EXCITE 2
EXCITE 4
EXCITE 5
EXCITE 6
EXCITE 7
EXCITE 8
EXCITE 9
EXCITE 11
EXCITE 12
EXCITE 13
EXCITE 14
EXCITE 15
EXCITE 16
EXCITE 17
EXCITE 18
EXCITE 19
EXCITE 20
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EXCITE 39
EXCITE 40
EXCITE 41
EXCITE 42
EXCITE 43
EXCITE 45
EXCITE 46
EXCITE 47
EXCITE 49
EXCITE 50
EXCITE 51
EXCITE 52
EXCITE 53
EXCITE 54
EXCITE 56
EXCITE 57
C INITIALIZE THE ACOUSTIC ENERGY INPUT AND ELEMENT ENERGY LEVELS.
C IF THE TYPE OF EXCITATION IS ACUSTIC,
C THEN CALCULATE THE ACOUSTIC ENERGY INPUT AND ELEMENT ENERGY LEVELS:
C ELSE IF THE TYPE OF EXCITATION IS MECHANICAL,
C THEN CALCULATE THE MECHANICAL ENERGY LEVELS:
SUBROUTINE ANSWER

C THIS SUBROUTINE SOLVES THE SEA SYSTEM OF EQUATIONS FOR
C ELEMENT ENERGY LEVELS AND STORES THE SOLUTION IN ARRAY
C ARR TO BE PRINTED OUT BY RITER. ANSWER IS CALLED FROM
C THE MAIN PROGRAM.

C THE FOLLOWING VARIABLES ARE USED IN THIS PROGRAM UNIT:
C NAME TYPE DESCRIPTION
C ----------------- -----------
C ABF (20) REAL AVERAGE ACCELERATION
C ALPHA (20, 20) REAL MATRIX OF COEFFICIENTS
C ETA (20) REAL ELEMENT ENERGY LEVELS
C ETA (20) REAL DAMPING
C FREQ (20) REAL FREQUENCY
C MASS (20) REAL MASS
C MODE (20) REAL NUMBER OF MODES IN BANDWIDTH
C NUFEL INT MEMBER OF ELEMENTS
C OMEGA REAL 2*PI*FREQUENCY
C TYPE CHAR TYPE OF OUTPUT
C PHIC (20, 20) REAL COUPLING COEFFICIENT
C S (20) REAL ACUSTIC ENERGY INPUT
C SFREG (20) REAL STARTING FREQUENCY
C SIZE INT SIZE OF REDUCED ALPHA ARRAY
C SLOPE (20) REAL SLOPE

C THE FOLLOWING COMMON BLOCKS ARE USED:
C BLOCK OTHER PROGRAM UNITS USING THIS COMMON BLOCK
C ------ ---------------------------------------------------
C CP REAL, JPROP, EXCITE
C CP REAL, MP, PLATE, ROOM, CYLIND, JPROP, EXCITE
C CP REAL, JPROP, INPUT, JPROP, EXCITE, SOLVE, RITER, BLOCK DATA
C CP REAL, JPROP, RITER, BLOCK DATA
C CP REAL, MP, PLATE, ROOM, CYLIND, EXCITE, BLOCK DATA
C CP REAL, JPROP, EXCITE
C CP REAL, EXCITE, SOLVE
C CP REAL, SOLVE
C CP REAL, RITER

C FOR EACH ELEMENT

ANSWER 2
ANSWER 3
ANSWER 4
ANSWER 5
ANSWER 6
ANSWER 7
ANSWER 8
ANSWER 9
ANSWER 10
ANSWER 11
ANSWER 12
ANSWER 13
ANSWER 14
ANSWER 15
ANSWER 16
ANSWER 17
ANSWER 18
ANSWER 19
ANSWER 20
ANSWER 21
ANSWER 22
ANSWER 23
ANSWER 24
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ANSWER 26
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ANSWER 45
ANSWER 46
ANSWER 47
ANSWER 48
ANSWER 49
ANSWER 50
ANSWER 51
ANSWER 52
ANSWER 53
ANSWER 54
ANSWER 55
ANSWER 56
ANSWER 57
ANSWER 58
ANSWER 59
ANSWER 60
ANSWER 61
DO 130 I = 1, NUMEL
C SET THE DAMPING FACTOR EQUAL TO THE INPUT VALUE
   130 E : = ETA(I)
   E : = ETA(I)
   SLOPE11 : = SLOPE(I) / 20.
C IF DAMPING IS FREQUENCY DEPENDENT AND THE ANALYSIS FREQUENCY
C IS GREATER THAN THE STARTING FREQUENCY OF THE DEPENDENCY,
C CALCULATE THE DAMPING FACTOR
   IF (SLOPE(I) .NE. 0.0 .AND. FREQ .GT. SFREQ(I))
      ETA(I) : = ETA(I) * (FREQ / SFREQ(I)) ** SLOPE(I)
C IF THIS IS NOT THE LAST ELEMENT,
   IF (I .NE. NUMEL) 60 TO 50
C THEN FOR EACH SUCCESSING ELEMENT,
IPLUS : = I + 1
DC - 40 J = 1, IPLUS
C CALCULATE THE I-TH ROW OF ALPHA TO THE RIGHT OF THE MAIN
   133 C DIAGONAL
   ALPHAT(I,J) = MODES(JJ) * PHI(J,J)
C CALCULATE THE I-TH COLUMN OF ALPHA BELOW THE MAIN DIAGONAL
   134 ALPHAT(I,J) = MODES(JJ) * PHI(J,J)
   135 CONTINUE
C END IF
C CALCULATE ALPHA ON THE MAIN DIAGONAL
   136 ALPHA(I,I) = OMEGA * ETA(I)
DC 60 J = 1, NUMEL
   1371 ALPHA(I,J) = ALPHA(I,J) + MODES(J) * PHI(J,J)
   138 CONTINUE
100 CONTINUE
C INITIALIZE SIZE
   139 SIZE : = NUMEL
C DO FOR EACH ELEMENT
   140 DO 150 I = 1, NUMEL
C IF THE ENERGY LEVEL IS ALREADY KNOWN,
      IF (E(I) .EQ. 0.0) GO TO 150
C THEN DO FOR EACH ELEMENT
   141 DC 150 J = 1, NUMEL
C SUBTRACT FROM THE ACOSIC ENERGY ARRAY S THAT PORTION OF
C THE VALUE WHICH CAME FROM THE PRODUCT OF THE ALPHA ARRAY
   142 S(I,J) : = S(I,J) - ALPHA(I,J) * E(I)
   143 CONTINUE
   144 C DECREMENT SIZE TO SHOW THAT THE I-TH ROW AND COLUMN WILL BE
C ELIMINATED FROM THE ALPHA ARRAY WHEN IT BECOMES EMPTY AND THE
C I-TH ELEMENT FROM THE S ARRAY WHEN IT BECOMES EMPTY
   145 SIZE : = SIZE - 1
C END IF
   146 150 CONTINUE
C CALL SOLVE TO CREATE THE REDUCED ARRAYS AND SOLVE THE MATRIX
C FILLING
   CALL SOLVE (AMAT, SMAT, SIZE)
C DO FOR EACH ELEMENT
   148 DO 150 I = 1, SIZE
C PUT THE SOLUTION IN BAR
   149 AMAT(I,AF) = E(I) * OMEGA ** 2 / MASS(I)
   150 C IF THE DEFAULT OUTPUT TYPE PSD IS SELECTED, PUT ARAR IN THAT FORM
   IF (TSSH .EQ. 1.0) 60 TO 110
      16094 AMAT(I,AF) = AMAT(I,AF) / (G ** 2 .* FREQ .* 4.33)
      16011
<table>
<thead>
<tr>
<th>Line</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1393</td>
<td>GO TO 200</td>
<td>Go to line 200</td>
</tr>
<tr>
<td>1395a</td>
<td>C ELSE IF THE OUTPUT TYPE IS AW</td>
<td>Conditional else if the output type is AW</td>
</tr>
<tr>
<td>1395a</td>
<td>THE ARRAY IN THAT FORM</td>
<td>In that form</td>
</tr>
<tr>
<td>1395a</td>
<td>INC</td>
<td>Increment</td>
</tr>
<tr>
<td>1395a</td>
<td>ARRAY(I,AF) = SQRT(AW) if AF)</td>
<td>Array in that form</td>
</tr>
<tr>
<td>1395a</td>
<td>/ G</td>
<td>Divide by G</td>
</tr>
<tr>
<td>1396</td>
<td>C END IF</td>
<td>End if</td>
</tr>
<tr>
<td>1397</td>
<td>200 CONTINUE</td>
<td>Continue to line 200</td>
</tr>
<tr>
<td>1398</td>
<td>RETURN</td>
<td>Return</td>
</tr>
<tr>
<td>1399</td>
<td>END</td>
<td>End program</td>
</tr>
</tbody>
</table>
SUBROUTINE SOLVE

C THIS SUBROUTINE CREATES MATRIX A + T F. GM ALPHA BY ELIMINATING
C THOSE ROWS AND COLUMNS REPRESENTING ELEMENTS FOR WHICH THE
C ENERGY LEVELS ARE ALREADY KNOWN. IN THE SAME WAY, SPAT IS
C CREATED FROM S. SURROUNDS GASSEM F. 3 TRARY SYS$MATHS:ATS
C IS THEN CALLED TO SOLVE THE MATRIX E. ON AMAT*/=S$MAT FOR X.
C GASSEM PUTS THE SOLUTION IN S$MAT, SO THIS SUBROUTINE PUTS
C THE RESULTS IN E, LEAVING INTACT THOSE ELEMENTS OF E
C WHICH WERE ALREADY KNOWN. SOLVE IS CALLED BY ANSWER.

C THE FOLLOWING VARIABLES ARE USED IN THIS PROGRAM UNIT:

C NAME TYPE DESCRIPTION
C ------- ------ ------------
C AL$MAT(20X20) REAL MATRIX OF COEFFICIENTS
C AMAT$SIZE SIZE REAL REDUCED ALPHA ARRAY
C DET REAL DETERMINANT OF AMAT
C E(20) REAL ELEMENT ENERFy LEVELS
C NUMEL INT NUMBER OF ELEMENTS
C S(20) REAL ACOUSTIC ENERGY INPUT
C SIZE INT SIZE OF AMAT AND S$MAT
C S$MAT SIZE REAL REDUCED S ARRAY

C THE FOLLOWING COMMON BLOCKS ARE USED:

C BLOCK OTHER PROGRAM UNITS USING THIS COMMON BLOCK
C ------- -------------------------------
C CB7 EPROP:INPUT, JPROP:EXCITE, ANSWER:STATE:BLOCK DATA
C CB15 EXCITE:ANSWER
C CB16 ANSWER
C CB17
C
C INTEGER SIZE
C DIMENSION AMAT$SIZE, S$MAT
C COPROM /CB7/ NUMEL=6
C COPROM /CB15/ S(20), E(20)
C COPROM /CB16/ AMAT(20X20)
C 350 FORMAT (19*** ERROR *** THE DETERMINANT OF THE SEA F. 
C 1 IF THE TRANPOSITION MATRIX IS 0. IF1 HENCE THERE IS NO SOLUTION. !
C 2 THIS ERROR WILL CAUSE THE PROGRAM TO ABORT. !
C $ THIS ERROR WAS DISCOVERED BY SURROUNTE SOLVE. !

C INITIALIZE II
C
II = 0
C DG FOR EACH ELEMENT FOR WHICH ENERGY LEVELS ARE UNKNOWN
DO 100 I = 1, SIZE
C INCREMENT II
10
II = II + 1
C IF THE ENERGY LEVEL FOR ELEMENT II IS KNOWN, GO TO NEXT ELEMENT
C IF (E(II) = -2. = 0.) GC TO 10
C ELSE INITIALIZE J1
C
J1 = 0
C DG FOR EACH ELEMENT FOR WHICH ENERGY LEVELS ARE UNKNOWN
DO AO & = 1, SIZE
C INCREMENT J1
30
J1 = J1 + 1
C IF ENERGY LEVEL FOR ELEMENT J1 IS KNOWN, GO TO NEXT ELEMENT

SOLVE 2
SOLVE 3
SOLVE 4
SOLVE 5
SOLVE 6
SOLVE 7
SOLVE 8
SOLVE 9
SOLVE 10
SOLVE 11
SOLVE 12
SOLVE 13
SOLVE 14
SOLVE 15
SOLVE 16
SOLVE 17
SOLVE 18
SOLVE 19
SOLVE 20
SOLVE 21
SOLVE 22
SOLVE 23
SOLVE 24
SOLVE 25
SOLVE 26
SOLVE 27
SOLVE 28
SOLVE 29
SOLVE 30
SOLVE 31
SOLVE 32
SOLVE 33
SOLVE 34
SOLVE 35
SOLVE 36
SOLVE 37
SOLVE 38
SOLVE 39
SOLVE 40
SOLVE 41
SOLVE 42
SOLVE 43
SOLVE 44
SOLVE 45
SOLVE 46
SOLVE 47
SOLVE 48
SOLVE 49
SOLVE 50
SOLVE 51
SOLVE 52
SOLVE 53
SOLVE 54
SOLVE 55
SOLVE 56
SOLVE 57
IF (E(J) .NE. 0.) GO TO 30
C ELSE PUT THE VALUE OF ALPHA FOR ELEMENT PAIR I1,J1 IN AMAT
AMAT(I1,J1) = ALPHA(I1,J1)
C END IF
80 CONTINUE
C PUT THE VALUE OF S FOR ELEMENT I1 IN SMAT
SMAT(I1) = S(I1)
180 CONTINUE
C SOLVE THE MATRIX EQUATION
CALL GASSEP (AMAT, SIZE, DET, SMAT)
C IF THE DETERMINANT OF AMAT IS 0:
IF (DET .NE. 0.) GO TO 150
C THEN WRITE AN ERROR MESSAGE AND TERMINATE THE PROGRAM
WRITE (6,380)
SOLVE 40
SOLVE 50
SOLVE 60
SOLVE 61
SOLVE 62
SOLVE 63
SOLVE 64
SOLVE 65
SOLVE 66
UNIVAC 4
SOLVE 68
UNIVAC 5
SOLVE 70
SOLVE 71
UNIVAC 80
SOLVE 72
SOLVE 73
SOLVE 74
SOLVE 75
SOLVE 76
SOLVE 77
SOLVE 78
SOLVE 79
SOLVE 80
SOLVE 81
SOLVE 82
SOLVE 83
SOLVE 84
SOLVE 85
SOLVE 86
SOLVE 87
SUBROUTINE RITER

C THIS SUBROUTINE WRITES OUT THE RESULTS THAT ARE STORED IN
C ARRAY ARR1. RITER IS CALLED FROM THE MAIN PROGRAM.

C THE FOLLOWING VARIABLES ARE USED IN THIS PROGRAM UNIT:
C NAME TYPE DESCRIPTION
C ---- ----- ---------------
C ABAR(20,20) REAL AVERAGE ACCELERATION
C FTAR(40) REAL TABLE OF ANALYSIS FREQUENCIES
C NUMAF INT NUMBER OF ANALYSIS FREQUENCIES
C SUPEL INT NUMBER OF ELEMENTS
C OTYPE CHAR TYPE OF OUTPUT

C THE FOLLOWING COMMON BLOCKS ARE USED:
C BLOCK OTHER PROGRAM UNITS USING THIS COMMON BLOCK
C ---- -------------------------------
C CB1 MAIN,EPROP,BEAR,MEMBER,PLATE,POOR,CYLIN,BLOCK DATA
C CP7 EPROP,INPUT,PROP,EXCITE,ANSK,ANSA,SOLVE,BLOCK DATA
C CB8 EPROP,ANSK,BLOCK DATA
C CB11 ANS

C

CHARACTER*20 TITLE / 1PSD LEVELS (G=2/H2)* /
C RMS / 9 RMS
C COMMON /CB1/ FTAR(40),NUMAF,FREQ
C COMMON /CB7/ NUMEL,6
C COMMON /CB7/ SLOPE(20),SFREQ(20),ETA(20),OTYPE
C COMMON /CB17/ ABAR(20,40)
C 100 FORMAT (8/3X,TENTHR,24X,A20/)
C 14X,FREQ(H2)=X,ELEMENT 1,121)
C 110 FORMAT (F12.2,E1PE15.5E2))
C IF THE TYPE OF OUTPUT IS RMS, CHANGE THE HEADING ACCORDINGLY
C IF OTYPE EQ. "ANSA" TITLE = RMS
C DO FOR EACH ELEMENT IN GROUPS OF 4
C DO 20 I = 1, NUMEL, 4
C IPLUS3 WILL BE THE TERMINAL VARIABLE FOR IMPLIED DO LOOPS TO
C PRODUCE 4 COLUMNS UNLESS THERE ARE FEWER THAN 4 ELEMENTS
C REPAIRING TO BE LISTED
C IF (NUMEL EQ. 3) 131
C WRITE THE HEADING FOR THESE 4 ELEMENTS
C WRITE (6/100) TITLE,J,YJ,I1,PLUS3)
C DO FOR EACH ANALYSIS FREQUENCY
C DO 10 J = 1, NUMAF
C WRITE THE RESULTS
C WRITE (6/110) FTAR(J),EARN(J),X,K1,PLUS3)
C CONTINUE
C 10 CONTINUE
C 20 CONTINUE
C RETURN
C END
C THE FOLLOWING VARIABLES ARE USED IN THIS PROGRAM UNIT:
C NAME TYPE DESCRIPTION
C ------ ----- ---------------
C ERROR LOG TRUE IF A FATAL ERROR HAS OCCURRED
C FREQ(40) REAL TABLE OF ANALYSIS FREQUENCIES
C G REAL GRAVITATIONAL CONSTANT
C INPUT INT NUMBER OF INPUT RECORDS READ
C MASS(20) REAL MASS
C N(20) REAL MOBIL DENSITY
C SLOPE REAL SLOPE
C THE FOLLOWING COMMON ARE USED:
C BLOCK OTHER PROGRAM UNITS USING THIS COMMON BLOCK
C ------ ---------------
C CB1 MAIN,PROP,BEAM-,PLATE,RCCP,CYLIN,RIER
C CB2 MAIN,PROP,INPUT
C CB7 PROP,INPUT,PROP,EXCITE,ANSWER,SOLVE,RIER
C CB8 PROP,ANSWER,INPUT
C CB9 PROP,BEAM,REBAR,PLATE,RCCP,CYLIN,PROP,EXCITE
C CB10 PROP,INPUT
C CB11 BEAM,REBAR,PLATE,RCCP,CYLIN,ANSWER
C REAL N,MASS
C LOGICAL ERROR
C COMMON /CB1/ FREQ(40),NUMFREX
C COMMON /CB2/ ERROR
C COMMON /CB7/ NUMFREX
C COMMON /CB8/ SLOPE(20),FREQ(20),ETA(20),OTYPE
C COMMON /CB9/ NUMFREX
C COMMON /CB10/ INPUT
C COMMON /CB11/ MASS(20)
C DATA N,SLOPE,MASS,INPUT,ERROR /840 0.0 365.4 1 96 FALSE/
C DATA FREQ /1.5 2.5 3.5 4.5 5.5 6.5 7.5 8.5 9.5 10.5/
C 1 0.0 12.5 0.0 20.0 0.0 25.0 0.0 31.5 0.0 40.0 0.0 49.0 0.0 58.0 0.0 68.0 0.0 79.0 0.0 90.0 0.0
C 2 10.0 12.5 16.0 20.0 25.0 25.0 30.0 30.0 36.0 40.0 50.0 50.0 63.0 63.0 79.0 83.0 90.0 91.0 90.0
C 3 63.0 79.0 100.0 125.0 150.0 175.0 200.0 200.0 250.0 250.0 250.0
C 4 315.0 400.0 500.0 6300.0 800.0 1000.0
C ENC
Appendix II

SEA PROGRAM LOGIC AND FLOW
1. EPROP
   READ INITIAL INFORMATION
   WRITE ERROR MESSAGE
   WRITE ERROR MESSAGE
   WRITE ERROR MESSAGE
   WRITE ERROR MESSAGE
   SET ERROR FLAG
   LOOP FOR EACH ANALYSIS FREQUENCY
   EXIT

2. EPROP2
   RETURN

GENERAL PAGE IS OF QUALITY
BEAM

CALCULATE THE PARTIAL SUB-ELEMENT MODAL DENSITY

IS STIFFNESS REDUCTION REQUIRED?

YES

REDUCE BY \( \frac{1}{\sqrt{2}} \)

NO

LOOP FOR EACH ANALYSIS FREQUENCY

SUM MASS TO THE ELEMENT MASS

CALCULATE ANGULAR VELOCITY

CALCULATE SUB-ELEMENT MODAL DENSITY

SUM TO THE ELEMENT MODAL DENSITY

RETURN

RETURN

SLT ELEMENT VALUES TO SUB-ELEMENT VALUES

IS THE MAIN SUB-ELEMENT?

YES

RETURN

NO
MEMBR

CALCULATE THE PARTIAL SUB-ELEMENT MODAL DENSITY

IS STIFFNESS REDUCTION REQUIRED?

YES → REDUCE BY \( \frac{1}{\sqrt{2}} \)

NO → LOOP FOR EACH ANALYSIS FREQUENCY

SUM MACS TO THE ELEMENT MASS

IS THIS THE MAIN SUB-ELEMENT?

NO → RETURN

YES → CALCULATE ANGULAR VELOCITY

SET ELEMEHT VALUES TO SUB-ELEMENT VALUES

SUM TO THE CLEMENT MODAL DENSITY

SET FLAG TO INDICATE THAT FOLLOWING SUB-ELEMENTS ARE NOT MAIN

RETURN
PLATE

CALCULATE THE SUB-ELEMENT MODAL DENSITY

2: STIFFNESS REDUCTION REQUIRED

YES

REDUCE BY \( \frac{1}{10} \)

LOOP FOR EACH ANALYSIS FREQUENCY

NO

SUM MASS TO THE ELEMENT MASS

SUM TO THE ELEMENT MODAL DENSITY

IS THIS THE MAIN ELEMENT?

NO

RETURN

YES

SET ELEMENT VALUES TO SUB-ELEMENT VALUES

SET FLAG TO INDICATE THAT FOLLOWING SUB-ELEMENTS ARE NOT MAIN

RETURN
ROOM

CALCULATE THE PARTIAL SUB-ELEMENT MODEL DENSITY

IS STIFFNESS REDUCTION REQUIRED?

YES

REDUCE BY \( \frac{1}{\sqrt{2}} \)

NO

LOOP FOR EACH ANALYSIS FREQUENCY

SUM MASS TO THE ELEMENT MASS

CALCULATE ANGULAR VELOCITY

CALCULATE SUB-ELEMENT MODEL DENSITY

SUM TO THE ELEMENT MODEL DENSITY

SET ELEMENT VALUES TO SUB-ELEMENT VALUES

SET FLAG TO INDICATE THAT FOLLOWING SUB-ELEMENTS ARE NOT MAIN

RETURN

RETURN
CYLIN

CALCULATE THE SUB-ELEMENT MODAL DENSITY

IS STIFFNESS REDUCTION REQUIRED?

YES

REDUCE BY $\frac{1}{\sqrt{2}}$

NO

LOOP FOR EACH ANALYSIS FREQUENCY

CALCULATE ANGULAR VELOCITY

CALCULATE THE FREQUENCY CRITERION

IS CRITERION $> 1$?

YES

REDUCE SUB-ELEMENT MODAL DENSITY

NO

SUM TO THE ELEMENT MODAL DENSITY

RETURN

SUM MAC TO THE ELEMENT MAC

IS THIS THE MAIN SUB-ELEMENT?

NO

RETURN

SET ELEMENT VALUES TO SUB-ELEMENT VALUES

SET FLAG TO INDICATE THAT FOLLOWING SUB-ELEMENTS ARE NOT MAIN

RETURN
ORIGINAL PAGE IS OF POOR QUALITY.
**SIGF**

**LOOP**
- FOR EACH ELEMENT OF THE TABLE BEGINT FIRST AND LAST

**YES**
- NEXT ELEMENT OF THE TABLE

**NO**
- THIS ELEMENT OF THE TABLE

**EXIT**

**SET INDEX TO 16 (NUMBER OF ELEMENTS IN THE TABLE)**

**CALCULATE SIGF AS DECREASING FUNCTION**

**INTERPOLATE**

**RETURN**

**INTERPOLATE**

**RETURN**

**THE TABLE CONSISTS OF 16 VALUES; THE FIRST AND LAST ARE USED FOR INTERPOLATION**
ECCITL

LOOP FOR EACH ELEMENT

RETURN

TYPE OF EXCITATION = MECHANICAL?

NO

TYPE OF EXCITATION = ACoustIC?

YES

CALCULATE CRITICAL FREQUENCY

12

SIGF

CALCULATE RADIATION EFFICIENCY

CALCULATE ACOUSTIC ENERGY INPUT

NO

TYPE OF MECHANICAL INPUT = RMS?

YES

CALCULATE ELEMENT ENERGY LEVEL AS PSD

CALCULATE ELEMENT ENERGY LEVEL AS RMS
Appendix III

SEA PROGRAM INPUT LIST

MATERIALS EXPERIMENT ASSEMBLY - EXAMPLE 2
LENGTH = 0
PRESSURE = 0
STIFFNESS REDUCTION REQUIRED = F
RADIUS = 0
VOLUME = 0
SPEED OF SOUND IN ROOM MEDIUM = 0
ADDED MASS = 0
SUB-ELEMENT NUMBER = 4
TYPE OF SUB-ELEMENT = P
DENSITY = 2.61700E-04
MODULUS OF ELASTICITY = 1.00000E+07
THICKNESS = 2.50000E-01
AREA = 6.90000E+02
POISSONS RATIO = 3.30000E-01
LENGTH = 0
PRESSURE = 0
STIFFNESS REDUCTION REQUIRED = F
RADIUS = 0
VOLUME = 0
SPEED OF SOUND IN ROOM MEDIUM = 0
ADDED MASS = 0
SUB-ELEMENT NUMBER = 5
TYPE OF SUB-ELEMENT = P
DENSITY = 2.61700E-04
MODULUS OF ELASTICITY = 1.00000E+07
THICKNESS = 9.50000E-02
AREA = 3.93000E+03
POISSONS RATIO = 3.30000E-01
LENGTH = 0
PRESSURE = 0
STIFFNESS REDUCTION REQUIRED = F
RADIUS = 0
VOLUME = 0
SPEED OF SOUND IN ROOM MEDIUM = 0
ADDED MASS = 0
SUB-ELEMENT NUMBER = 6
TYPE OF SUB-ELEMENT = P
DENSITY = 2.61700E-04
MODULUS OF ELASTICITY = 1.00000E+07
THICKNESS = 2.50000E-01
AREA = 1.22013E+03
POISSONS RATIO = 3.30000E-01
LENGTH = 0
PRESSURE = 0
STIFFNESS REDUCTION REQUIRED = F
RADIUS = 0
VOLUME = 0
SPEED OF SOUND IN ROOM MEDIUM = 0
ADDED MASS = 0
SUB-ELEMENT NUMBER = 7
TYPE OF SUB-ELEMENT = P
DENSITY = 2.61700E-04
MODULUS OF ELASTICITY = 1.00000E+07
THICKNESS = 2.50000E-01
AREA = 1.74720E+03
POISSONS RATIO = 3.30000E-01
LENGTH = 0
PRESSURE = 0
STIFFNESS REDUCTION REQUIRED = F
RADIUS = 0
VOLUME = 0
SPEED OF SOUND IN ROOM MEDIUM = 0
ADDED MASS = 0
SUB-ELEMENT NUMBER = 8
TYPE OF SUB-ELEMENT = P
MODULUS OF ELASTICITY = 2.61700E-04
MODULUS OF ELASTICITY = 1.00000E+07
THICKNESS = 4.64600E-02
AREA = 2.04637E+03
POISSONS RATIO = 3.38000E-01
LENGTH = 0.
PRESSURE = 0.
STIFFNESS REDUCTION REQUIRED = F
RADIUS = 0.
VOLUME = 0.
SPEED OF SOUND IN ROOM MEDIUM = 0.
ADDED MASS = 0.
SUB-ELEMENT NUMBER = 9
TYPE OF SUB-ELEMENT = P
DENSITY = 2.61700E-04
MODULUS OF ELASTICITY = 1.00000E+07
THICKNESS = 1.25000E-01
AREA = 7.47320E+02
POISSONS RATIO = 3.38000E-01
LENGTH = 0.
PRESSURE = 0.
STIFFNESS REDUCTION REQUIRED = F
RADIUS = 0.
VOLUME = 0.
SPEED OF SOUND IN ROOM MEDIUM = 0.
ADDED MASS = 0.
SUB-ELEMENT NUMBER = 10
TYPE OF SUB-ELEMENT = P
DENSITY = 2.61700E-04
MODULUS OF ELASTICITY = 1.00000E+07
THICKNESS = 5.62000E-01
AREA = 6.19000E+01
POISSONS RATIO = 3.38000E-01
LENGTH = 0.
PRESSURE = 0.
STIFFNESS REDUCTION REQUIRED = F
RADIUS = 0.
VOLUME = 0.
SPEED OF SOUND IN ROOM MEDIUM = 0.
ADDED MASS = 0.
SUB-ELEMENT NUMBER = 11
TYPE OF SUB-ELEMENT = P
DENSITY = 2.61700E-04
MODULUS OF ELASTICITY = 1.00000E+07
THICKNESS = 2.30000E-01
AREA = 1.69920E+03
POISSONS RATIO = 3.38000E-01
LENGTH = 0.
PRESSURE = 0.
STIFFNESS REDUCTION REQUIRED = F
RADIUS = 0.
VOLUME = 0.
SPEED OF SOUND IN ROOM MEDIUM = 0.
ADDED MASS = 0.
SUB-ELEMENT NUMBER = 12
TYPE OF SUB-ELEMENT = P
DENSITY = 2.61700E-04
MODULUS OF ELASTICITY = 1.00000E+07
THICKNESS = 3.75000E-01
AREA = 3.00000E+01
POISSONS RATIO = 3.38000E-01
LENGTH = 0.
PRESSURE = 0.
STIFFNESS REDUCTION REQUIRED = F
RADIUS = 0.
VOLUME = 0.
SPEED OF SOUND IN ROOM MEDIUM = 0.
ADDED MASS = 0.
SUB-ELEMENT NUMBER = 13
TYPE OF SUB-ELEMENT = P
DENSITY = 2.61700E-04
MODULUS OF ELASTICITY = 1.00000E+07
THICKNESS = 1.00000E-01
AREA = 3.54160E+02
POISSONS RATIO = 3.30000E-01
LENGTH = 0.
PRESSURE = 0.
STIFFNESS REDUCTION REQUIRED = F
RADIUS = 0.
VOLUME = 0.
SPEED OF SOUND IN ROOM MEDIUM = C.
ADDED MASS = 0.
SUB-ELEMENT NUMBER = 14
TYPE OF SUB-ELEMENT = P
DENSITY = 2.61700E-04
MODULUS OF ELASTICITY = 1.00000E+07
THICKNESS = 1.50000E-01
AREA = 7.36200E+02
POISSONS RATIO = 3.30000E-01
LENGTH = 0.
PRESSURE = 0.
STIFFNESS REDUCTION REQUIRED = F
RADIUS = 0.
VOLUME = 0.
SPEED OF SOUND IN ROOM MEDIUM = C.
ADDED MASS = 0.
SUB-ELEMENT NUMBER = 15
TYPE OF SUB-ELEMENT = P
DENSITY = 2.61700E-04
MODULUS OF ELASTICITY = 1.00000E+07
THICKNESS = 2.00000E-01
AREA = 1.98000E+02
POISSONS RATIO = 3.30000E-01
LENGTH = 0.
PRESSURE = 0.
STIFFNESS REDUCTION REQUIRED = F
RADIUS = 0.
VOLUME = 0.
SPEED OF SOUND IN ROOM MEDIUM = C.
ADDED MASS = 0.
SUB-ELEMENT NUMBER = 16
TYPE OF SUB-ELEMENT = P
DENSITY = 2.61700E-04
MODULUS OF ELASTICITY = 1.00000E+07
THICKNESS = 2.50000E-01
AREA = 1.07100E+02
POISSONS RATIO = 3.30000E-01
LENGTH = 0.
PRESSURE = 0.
STIFFNESS REDUCTION REQUIRED = F
RADIUS = 0.
VOLUME = 0.
SPEED OF SOUND IN ROOM MEDIUM = C.
ADDED MASS = 0.
SUB-ELEMENT NUMBER = 17
TYPE OF SUB-ELEMENT = P
DENSITY = 2.61700E-04
MODULUS OF ELASTICITY = 1.00000E+07
THICKNESS = 1.00000E-01
AREA = 7.91500E+01
POISSONS RATIO = 3.30000E-01
LENGTH = 0.
PRESSURE = 0.
STIFFNESS REDUCTION REQUIRED = F
RADIUS = 0.
VOLUME = 0.
SPEED OF SOUND IN ROOM MEDIUM = C.
ADDED MASS = 0.
STIFFNESS REDUCTION REQUIRED = F
RADIUS = 0.
VOLUME = 0.
SPEED OF SOUND IN ROOM MEDIUM = C.
ADDED MASS = 0.

SUB-ELEMENT NUMBER = 18
TYPE OF SUB-ELEMENT = P
DENSITY = 2.61700E-04
MODULUS OF ELASTICITY = 1.60000E+07
THICKNESS = 2.50000E-01
AREA = 1.97100E+01
POISSONS RATIO = 3.30000E-01
LENGTH = 0.
PRESSURE = 0.

STIFFNESS REDUCTION REQUIRED = F
RADIUS = 0.
VOLUME = 0.
SPEED OF SOUND IN ROOM MEDIUM = C.
ADDED MASS = 0.

SUB-ELEMENT NUMBER = 19
TYPE OF SUB-ELEMENT = P
DENSITY = 2.61700E-04
MODULUS OF ELASTICITY = 1.60000E+07
THICKNESS = 2.00000E-01
AREA = 1.55250E+01
POISSONS RATIO = 3.30000E-01
LENGTH = 0.
PRESSURE = 0.

STIFFNESS REDUCTION REQUIRED = F
RADIUS = 0.
VOLUME = 0.
SPEED OF SOUND IN ROOM MEDIUM = C.
ADDED MASS = 0.

SUB-ELEMENT NUMBER = 20
TYPE OF SUB-ELEMENT = P
DENSITY = 2.61700E-04
MODULUS OF ELASTICITY = 1.00000E+07
THICKNESS = 1.80000E-01
AREA = 1.16476E+03
POISSONS RATIO = 3.30000E-01
LENGTH = 0.
PRESSURE = 0.

STIFFNESS REDUCTION REQUIRED = F
RADIUS = 0.
VOLUME = 0.
SPEED OF SOUND IN ROOM MEDIUM = C.
ADDED MASS = 0.

ELEMENT NUMBER = 2
NUMBER OF SUB-ELEMENTS = 4
TYPE OF EXCITATION =
TYPE OF MECHANICAL INPUT =
DAMPING = 1.00000E-02
SLOPE = -8.30480E-01
STARTING FREQUENCY = 2.50000E+02

SUB-ELEMENT NUMBER = 1
TYPE OF SUB-ELEMENT = P
DENSITY = 2.61700E-04
MODULUS OF ELASTICITY = 1.60000E+07
THICKNESS = 1.90000E-01
AREA = 3.54160E+02
POISSONS RATIO = 3.30000E-01
LENGTH = 0.
PRESSURE = 0.

STIFFNESS REDUCTION REQUIRED = F
RADIUS = 0.
VOLUME = 0.
SPEED OF SOUND IN ROOM MEDIUM = C.
ADDED MASS = 0.60000E-03
SUB-ELEMENT NUMBER = 2
TYPE OF SUB-ELEMENT = P
DENSITY = 2.61700E-04
MODULUS OF ELASTICITY = 1.00000E+07
THICKNESS = 1.50000E-01
AREA = 7.36000E+02
POISSONS RATIO = 3.30000E-01
LENGTH = 0.
PRESSURE = 0.
STIFFNESS REDUCTION REQUIRED = F
RADIUS = 0.
VOLUME = 0.
SPEED OF SOUND IN ROOM MEDIUM = C.
ADDED MASS = 0.
SUB-ELEMENT NUMBER = 3
TYPE OF SUB-ELEMENT = P
DENSITY = 2.61700E-04
MODULUS OF ELASTICITY = 1.00000E+07
THICKNESS = 2.00000E-01
AREA = 1.98000E+02
POISSONS RATIO = 3.30000E-01
LENGTH = 0.
PRESSURE = 0.
STIFFNESS REDUCTION REQUIRED = F
RADIUS = 0.
VOLUME = 0.
SPEED OF SOUND IN ROOM MEDIUM = C.
ADDED MASS = 0.
SUB-ELEMENT NUMBER = 4
TYPE OF SUB-ELEMENT = P
DENSITY = 2.61700E-04
MODULUS OF ELASTICITY = 1.00000E+07
THICKNESS = 2.50000E-01
AREA = 1.98000E+02
POISSONS RATIO = 3.30000E-01
LENGTH = 0.
PRESSURE = 0.
STIFFNESS REDUCTION REQUIRED = F
RADIUS = 0.
VOLUME = 0.
SPEED OF SOUND IN ROOM MEDIUM = C.
ADDED MASS = 0.
ELEMENT NUMBER = 3
NUMBER OF SUB-ELEMENTS = 3
TYPE OF EXCITATION =
TYPE OF MECHANICAL INPUT =
DAMPING = 1.00000E-02
SLOPE = -0.30480E-01
STARTING FREQUENCY = 2.50000E+02
SUB-ELEMENT NUMBER = 1
TYPE OF SUB-ELEMENT = P
DENSITY = 2.61700E-04
MODULUS OF ELASTICITY = 1.00000E+07
THICKNESS = 6.30000E-01
AREA = 9.76300E+01
POISSONS RATIO = 3.30000E-01
LENGTH = 0.
PRESSURE = 0.
STIFFNESS REDUCTION REQUIRED = T
RADIUS = 0.
VOLUME = 0.
SPEED OF SOUND IN ROOM MEDIUM = C.
ADDED MASS = 1.44800E-01
SUB-PHASE NUMBER = 2
TYPE OF SUB-ELEMENT = P
DENSITY = 2.61700E-04
MODULUS OF ELASTICITY = 1.00000E+07
THICKNESS = 2.50000E-01
AREA = 9.16700E+01
POISSONS RATIO = 3.30000E-01
LENGTH = 0.
PRESSURE = 0.
STIFFNESS REDUCTION REQUIRED = 1
RADIUS = 0.
VOLUME = 0.
SPEED OF SOUND IN ROOM MEDIUM = 6.
ADDED MASS = 0.

SUB-ELEMENT NUMBER = 5
NUMBER OF SUB-ELEMENTS = 1
TYPE OF EXCITATION =
TYPE OF MECHANICAL INPUT =
DAMPING = 1.00000E-02
SLOPE = -8.30480E-01
STARTING FREQUENCY = 2.50000E+02
ADDED MASS = 2.27000E-02

SUB-ELEMENT NUMBER = 1
TYPE OF SUB-ELEMENT = P
DENSITY = 2.61700E-04
MODULUS OF ELASTICITY = 1.00000E+07
THICKNESS = 2.50000E-01
AREA = 8.76300E+01
POISSONS RATIO = 3.30000E-01
LENGTH = 0.
PRESSURE = 0.
STIFFNESS REDUCTION REQUIRED = 1
RADIUS = 0.
VOLUME = 0.
SPEED OF SOUND IN ROOM MEDIUM = 6.
ADDED MASS = 0.

SUB-ELEMENT NUMBER = 3
TYPE OF SUB-ELEMENT = P
DENSITY = 2.61700E-04
MODULUS OF ELASTICITY = 1.00000E+07
THICKNESS = 2.50000E-01
AREA = 6.21920E+02
POISSONS RATIO = 3.30000E-01
LENGTH = 0.
PRESSURE = 0.
STIFFNESS REDUCTION REQUIRED = 1
RADIUS = 0.
VOLUME = 0.
SPEED OF SOUND IN ROOM MEDIUM = 6.
ADDED MASS = 0.

SUB-ELEMENT NUMBER = 4
NUMBER OF SUB-ELEMENTS = 1
TYPE OF EXCITATION =
TYPE OF MECHANICAL INPUT =
DAMPING = 1.00000E-02
SLOPE = -8.30480E-01
STARTING FREQUENCY = 2.50000E+02
ADDED MASS = 2.27000E-02

SUB-ELEMENT NUMBER = 6
TYPE OF SUB-ELEMENT = P
DENSITY = 2.61700E-04
MODULUS OF ELASTICITY = 1.00000E+07
THICKNESS = 2.50000E-01
AREA = 8.76300E+01
POISSONS RATIO = 3.30000E-01
LENGTH = 0.
PRESSURE = 0.
STIFFNESS REDUCTION REQUIRED = 1
RADIUS = 0.
VOLUME = 0.
SPEED OF SOUND IN ROOM MEDIUM = 6.
ADDED MASS = 0.

SUB-ELEMENT NUMBER = 7
TYPE OF SUB-ELEMENT = P
DENSITY = 2.61700E-04
MODULUS OF ELASTICITY = 1.00000E+07
THICKNESS = 2.50000E-01
AREA = 8.76300E+01
POISSONS RATIO = 3.30000E-01
LENGTH = 0.
PRESSURE = 0.
STIFFNESS REDUCTION REQUIRED = 1
RADIUS = 0.
<table>
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<th>Volume</th>
<th>Speed of Sound in Room Medium</th>
<th>Added Mass</th>
<th>Sub-Element Number</th>
<th>Type of Sub-Element</th>
<th>Density</th>
<th>Modulus of Elasticity</th>
<th>Thickness</th>
<th>Area</th>
<th>Poisson's Ratio</th>
<th>Length</th>
<th>Pressure</th>
<th>Stiffness Reduction Required</th>
<th>Radius</th>
<th>Volume</th>
<th>Speed of Sound in Room Medium</th>
<th>Added Mass</th>
</tr>
</thead>
<tbody>
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<td>0</td>
<td>0</td>
<td>1.39790E+00</td>
<td>2</td>
<td>P</td>
<td>2.61700E-04</td>
<td>1.00000E+07</td>
<td>3.50000E-01</td>
<td>1.99960E+02</td>
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<td>0</td>
<td>0</td>
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INSERTION LOSS FACTOR = 1.00000E+02
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SECOND ELEMENT = 3
TYPE OF JOINT = BJ
NUMBER OF SIDES = 0
JOINT LENGTH = 1.23840E+02
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INSERTION LOSS FACTOR = 1.00000E+02
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