BRIEF TECHNICAL NOTES ON VIBRATION CONTROL

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VIBRATION ANALYSIS WITH COMPUTER MODELS

There can be great mystery and intrigue in vibration problems! The source of vibration is often difficult to understand and trace. People have been puzzled by problems such as:

- Why the building shakes late in the afternoon
- Why the floor shakes 70' from the screener but nowhere else
- Why there are ripples in the cup of coffee
- Why the duct cracks at such low vibration

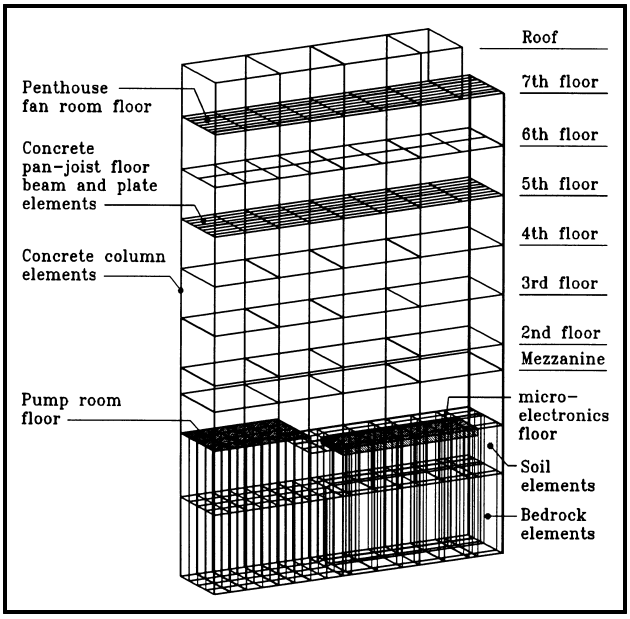
To understand these problems, computer models are sometimes used along with testing. In fact, computer models are used almost exclusively in the design phase to simulate performance before the structural system or prototype is built.

Automobile designers and engineers use super computers to mathematically model vehicles crashing into walls. Engineers can see the damage graphically and predict which parts will fail, etc., without building the costly prototype. This allows alternative designs to be more easily examined.

COMPUTER MODELS

Computerized structural models are simply mathematical simulations of real structures. The model is a data base describing the geometry, materials and loads. The simulation shows model geometry and how the structure will respond during loading.

Models are typically formed from finite elements that are either linear, plane or solid members combined to represent the structural system. An example of a building model using various combinations of elements follows.



Example of a building model

In many building structures involving ground vibration, the model often includes elements representing the soil and/or rock as well as the foundation columns, beams and floors of the facility. With this degree of detail, two things can be accomplished:

- Vibration transmission through the ground from adjacent sources can be studied
- Boundary conditions for the soil/foundation can be more accurately represented

As seen above, computer models can accurately represent the geometric configuration, material properties and dynamic loading.

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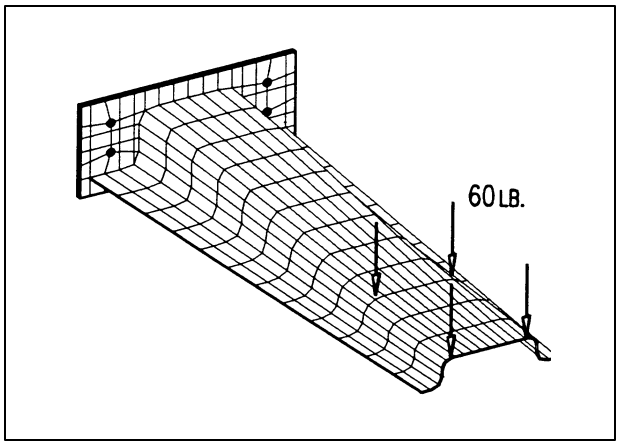


Sample model of an equipment part

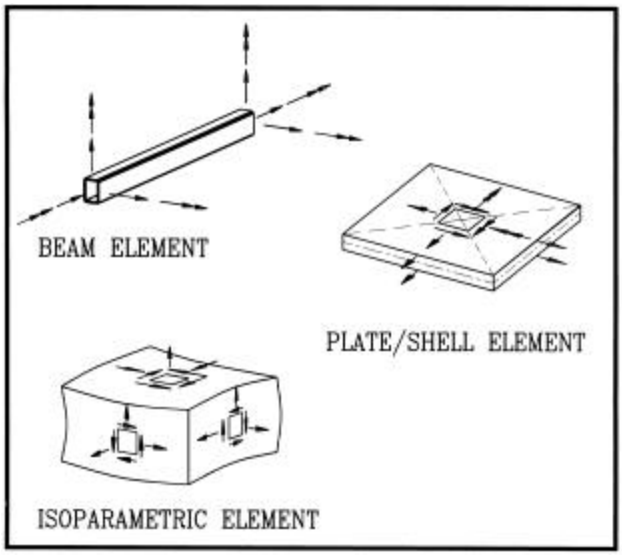
A sample model of an equipment piece part is shown above. This model is composed totally of flat-plate elements.

FINITE ELEMENTS

Many structural systems, large and small, can be visualized as an assemblage of members or parts connected at finite locations. Framing systems of columns, beams and braces are good examples.

For continuous structures of plates and solids, the subdivision process depends on engineering judgment for accuracy. The model is divided into a mesh of finite elements to accurately simulate the real structure as closely as possible.

Many types of finite elements are available. Some common examples are shown below:



Types of finite elements

COMPUTERIZED VIBRATION ANALYSIS

Computerized vibration analysis can reduce the cost of trial-and-error to study issues such as:

- displacements at various equipment speeds
- resonant frequency conditions
- structure-borne vibration transmission

Usually the analysis determines the fundamental frequencies and mode shapes of the structural model with the accuracy based on mesh size. The frequency range of modes extracted should cover the complete range of excitation.

At various points on the model, vibration amplitudes can be examined over time. This process is called time-history analysis with time-varying dynamic loads either within the structure or at the base.

Many types of dynamic loads are given in terms of base motion versus frequency. With this type of data, a response spectrum analysis can be done for earthquake or over-the-road studies of equipment.

Whatever method is used, computerized vibration analysis requires special skills in modeling detail, dynamic loading and interpretation of the results. Vibration and dynamic problems are often complex.

IN SUMMARY

Remember, vibration analysis with models:

- represents the real structure mathematically
- reduces the cost of trial-and-error design
- predicts shock and vibration problems
- requires special skills in dynamic analysis

ESI ENGINEERING, INC.

ESI Engineering, Inc. (ESI) offers services as a consultant to provide vibration control and isolation design. These services include:

- Completing Vibration Analyses
- Establishing Vibration Criteria
- Determining Isolation Requirements
- Monitoring Vibration Conditions

ESI offers services in vibration analysis of buildings, floors and equipment for many industries.

We would like to serve you. Please call us at:
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