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Brief 71-10414

NASA TECH BRIEF

Manned Spacecraft Center

Frame Modal Analysis

The problem:

For preliminary design studies of structures composed of general beam elements connected through rigid joints, the mode shapes and frequencies must be calculated. In addition, the stiffness and mass of frame structures must be computed. If the structure is fairly large, it must be broken down into several substructures or sections prior to calculation of the modal characteristics.

The solution:

The Frame Modal Analysis (FMA) computer model calculates the natural frequencies and modal displacements of three-dimensional frame structures. The program may also be used to generate the stiffness and mass matrices. The structure may, if required, be divided into several substructures or sections prior to calculation of the modal characteristics. Considerable flexibility in the arrangement of structural degrees of freedom is provided. A repeat feature for input data on members with identical physical properties is also provided.

Some of the structural modal characteristics and requirements are as follows:

1. Sections must be joined in an end-to-end configuration.
2. Structural joints must be rigid, except at the boundary, where fixed, hinged, or sliding conditions may be imposed.
3. Concentrated masses may be input for any degree of freedom.
4. Spring boundary conditions may be input directly.
5. Degrees of freedom which are unloaded or are associated with relatively insignificant inertias may be reduced from the final modal.
6. Stiffness and mass matrices may be punched on cards or stored on tape.
7. Multiple cases may be run on one job.

How it's done:

Input data to FMA includes member sectional properties and weights plus coordinates of the node points at which the members join. Stiffness matrices for each beam member are generated and combined, using the direct stiffness method, to form the structure stiffness matrix. A consistent mass matrix is formed using the stiffness information and the weight input data. Mode shapes and frequencies are then calculated by the Jacobi method, using the mass and stiffness matrices.

The principal steps performed by the FMA program are: (1) Generate the section stiffness and mass matrices, K_{sec} and M_{sec}, from individual member stiffness and mass properties; (2) shuffle and reduce K_{sec} and M_{sec}; (3) assemble section matrices to form system matrices, K_{sys} and M_{sys} (where applicable); (4) shuffle and reduce K_{sys} and M_{sys}; (5) form the system dynamic matrix; and (6) calculate the system frequencies and mode shapes.

Notes:

1. This program is written in FORTRAN IV for use on the IBM-360 computer.
2. Requests for further information may be directed to:

   COSMIC
   112 Barrow Hall
   University of Georgia
   Athens, Georgia 30601
   Reference: B71-10414

(continued overleaf)

Patent status:

No patent action is contemplated by NASA.

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