Modal Frequency Response Analysis using MSC.Nastran

1. Theoretical background for calculations in Nastran

In this section, a very brief description is given of how the calculation of frequency response functions works with Nastran's modal frequency response analysis. Therefore, the most important equations are given in a chronological order as applied by the programm.

After input of an bulk data file (*.bdf), Nastran assembles the system's mass and stiffness matrices, leading to a set of differential equations, displayed by eq. (1), already transformed in the frequency domain (damping is neclected at first).

$$\mathbf{M}\,\ddot{\mathbf{x}} + \mathbf{K}\,\mathbf{x} = \mathbf{f}(\omega) \tag{1}$$

Secondly, Nastran solves the characteristic equations (eq. (2)) for eigenvalues and computes the corresponding eigenmodes.

$$det\,(\mathbf{K} - \omega^2\,\mathbf{M}) = 0 \tag{2}$$

With the seperation approach in eq. (3), a modal transformation[1,3] is performed, which diagonalizes the system from eq. (1), using the orthogonality properties of the eigenvectors in the modal matrix $\mathbf{\Psi}$, consisting of the calculated eigenvectors.

$$\mathbf{x} = \mathbf{\Psi}\,\mathbf{q}(\omega)$$
$$\text{with } \mathbf{\Psi} = [\psi_1, \psi_2, \psi_3, \dots, \psi_N] \tag{3}$$

Hereby the system, consisting of N degrees of freedom, is decoupled, leading to a system of N single-mass oscillators, with each oscillator representing an eigenmode of the system in general coordinates q_i (eq. (4)).

$$m_i\,\ddot{q}_i(\omega) + k_i\,q_i(\omega) = p_i(\omega) \tag{4}$$

Here, m_i is the modal mass, k_i the modal stiffness, and $p_i = \psi_i^T \cdot \mathbf{f}$ the modal force. With the eigenfrequencies $\omega_i^2 = k_i / m_i$, eq. (4) can be transformed to eq. (5). Furthermore, damping can be introduced by a modal damping ratio ζ_i (eq. (6), [1]).

$$\ddot{q}_i(\omega) + \omega_i^2\,q_i(\omega) = \frac{p_i(\omega)}{m_i} \tag{5}$$

$$\ddot{q}_i(\omega) + 2\zeta_i\,\omega_i\,\dot{q}_i(\omega) + \omega_i^2\,q(\omega) = \frac{p_i(\omega)}{m_i} \tag{6}$$

The solution of this differential equation is well known and given by eq. (7) .

$$q_i(\omega) = \frac{1}{\omega_i^2 - \Omega_i^2 + i2\zeta_i\,\omega_i\,\Omega_i} \cdot \frac{\hat{p}_i(\omega)}{m_i} \tag{7}$$

Then, the solution for the system ist a linear combination of the solutions for all oscillators (eq. (8)).

Modal Frequency Response Analysis Using Msc Nastran

Alfred L. Wicks

Modal Frequency Response Analysis Using Msc Nastran:

Combining Acceleration and Displacement Dependent Modal Frequency Responses Using an MSC/NASTRAN DMAP Alter ,1996 **Multidisciplinary Aerospace Systems Optimization: Computational AeroSciences (CAS) Project** ,2001 *Fully-Coupled Fluid/Structure Vibration Analysis Using MSC/NASTRAN* ,1996 The Shock and Vibration Digest ,1987 Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 1 ,1991 **Parallel Computing: Advances And Current Issues, Proceedings Of The International Conference Parco2001** Gerhard R Joubert,A Murli,F J Peters,M Vanneschi,2002-07-30 The near future will see the increased use of parallel computing technologies at all levels of mainstream computing Computer hardware increasingly employs parallel techniques to improve computing power for the solution of large scale and computer intensive applications Cluster and grid technologies make possible high speed computing facilities at vastly reduced costs These developments can be expected to result in the extended use of all types of parallel computers in virtually all areas of human endeavour Computer intensive problems in emerging areas such as financial modelling data mining and multimedia systems in addition to traditional application areas of parallel computing such as scientific computing and simulation will lead to further progress Parallel computing as a field of scientific research and development has already become one of the fundamental computing technologies This book gives an overview of new developments in parallel computing at the start of the 21st century as well as a perspective on future developments **Nonlinear Random Response Prediction Using MSC/NASTRAN** Jay Howard Robinson,1993 **Proceedings of the 12th International Modal Analysis Conference** Dominick J. DeMichele,Society for Experimental Mechanics (U.S.),1994 **A Finite Element Procedure for Calculating Fluid-structure Interaction Using MSC/NASTRAN** ,1990 *Proceedings of the 17th International Modal Analysis Conference* Alfred L. Wicks,1999 **36th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference and AIAA/ASME Adaptive Structures Forum** ,1995 **MSC/NASTRAN Verification Problem Manual** MacNeal-Schwendler Corporation,1986 *Proceedings of NOISE-CON ...* ,1996 **Scientific and Technical Aerospace Reports** ,1984-04 A Collection of Technical Papers ,1988 **Broadband Transmission Loss Due to Reverberant Excitation** ,1999 **High Performance Structures and Materials II** C. A. Brebbia,Willy Patrick Wilde,2004 A range of topics relating to advanced types of structures particularly those based on new concepts or new types of materials Originally presented at the Second International Conference on High Performance Structures and Materials the papers contain detailed developments in design optimization manufacturing and experimentation Annual Index/abstracts of SAE Technical Papers ,2005 *AIAA Journal* American Institute of Aeronautics and Astronautics,2007 **Proceedings of the ASME Noise Control and Acoustics Division** ,2003

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