

Webinar: Simplifying Advanced Dynamic Analysis with Femap and Vibrata

Laura Hoffman, ATA Engineering June 29, 2021

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Dynamic Response Analysis in Femap

With Vibrata

- Femap is a powerful tool for pre/postprocessing
- Vibrata extends Femap with dynamic response capabilities
 - ➤ Steady-state frequency response analysis
 - ➢ Random analysis
 - ➢ Response spectrum analysis
 - ➤ Transient analysis
- Vibrata GUI streamlines dynamic response analysis



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Modal Dynamic Analysis

Brief Background

Vibrata uses normal modes to solve the equation of motion $M\ddot{u} + C\dot{u} + Ku = f$

> Assume harmonic approximation of displacement $u = Ue^{i\omega t}$

≻Eigenvalue problem

 $|-\omega^2 M + K| = 0$

>Nastran provides the normal modes (natural frequencies ω_i and mode shape φ_i) as the solution

Assume a subset of normal modes is sufficient to approximate displacement

Analysis type dictates the specific approach to solving the equation of motion



Vibrata Overview

Architecture, Nastran Input File Preparation and GUI

Requires Femap, MATLAB Runtime (MCR), finite element solver (Nastran)

Femap provides the FEM interaction and data display

≻Nastran solution sequence for normal modes (SOL 103, SEMODES)

➤ Mass normalization

> OP2 output request for physical response to be solved by Vibrata

> Analysis type specific input

➢ Vibrata GUI facilitates the analysis process

- ➤ Nastran op2 to Vibrata HDF5 database
- ➤ Event file definition
- ➤ Interface to Femap model





Vibrata's Unique Features

➢ Reuse event definition files

> Event definition files are text files that are simple to modify

➤Batch mode available from command prompt

≻ Run multiple events in series

- Import fully coupled damping matrix
 From Nastran or MATLAB ".mat" file
- ➤Random analysis
 - Compute RMS quantities directly, without computing response PSDs
 - ➤ Force limited input
- Displacement limiting with modal transient analysis



Vibrata Runtime Performance is Stellar

7x-12x Faster Than Alternatives



Notes

- Nastran default settings were used
- NX Response Dynamics was run with 16% fewer frequency solution points
- Nastran solution time includes ply von Mises
- The benchmark solutions do not use the Fast RMS approach
- Time does not include Vibrata vra5 database creation



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Simcenter Nastran 2020.1



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NX Response Dynamics 1872





Random Analysis

Random Analysis Using ISat Launch Configuration Model

➢ Base excitation to simulate response during ground test

> Launch adapter legs connected by RBE2

➤ Constraint applied at RBE2 independent node

Z-direction base excitation applied at RBE2 independent node using acceleration PSD



V:1 C:1



Random Analysis

- ➤General Procedure for Random Analysis ≻ Create Femap .modfem file Create a Vibrata event for Random Analysis Create Vibrata database from Nastran op2 > Define excitation function ➤ Set damping values \succ Select output for analysis ➢ Solve ➢ Post-process > Femap contour plots
 - ➢ Vibrata XY plots

V:1 C:1



Post-processing: PSDs of element internal forces





Post-processing: stress contour in Femap

Transient Analysis

V:1 C:1

- Transient Analysis Using ISat Deployed Configuration Model
 - Simulate dynamic response due to the firing of thrusters
 - Free-free model without launch adapter legs
 - Solar panels, antenna dishes and instrument package deployed
 - Thrust forces applied at thruster locations





Transient Analysis

- General Procedure for Transient Analysis Using ISat Deployed Configuration Model
 - ➤ Create Femap .modfem file
 - > Create a Vibrata event for Transient Analysis
 - Set analysis type to Modal Transient
 - > Set initial condition and duration
 - Create Vibrata database from Nastran op2
 - Define excitation function
 - > Set damping values
 - ➢ Select output for analysis
 - ➢ Solve
 - ➢ Post-process
 - > Femap contour plots
 - Femap deformed shape plots
 - Vibrata XY plots





Transient Analysis Input Data and Post-processing



Summary

- Vibrata/Femap enable dynamic analysis
 Normal modes solution from finite element solver required
- >Vibrata dynamic response solvers are fast and robust
 - Built-in solvers: Frequency Response, Response Spectrum, Random, and Transient
 - ➤ Custom dynamic response solver can be implemented using MATLAB
- >Vibrata GUI provides functionality to facilitate dynamic analysis
 - ➢ Solver parameters
 - ≻GUI for creating input functions
 - ➤ Output request selection
 - ➢ Post-processing



Contact Us



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