NX Response Simulation

Improving structural dynamic behavior of products

fact sheet

Siemens PLM Software www.siemens.com/plm

Summary

NX® Response Simulation software is an add-on module to the NX Advanced Simulation environment that predicts the dynamic responses of structural systems under various loading conditions. Augmenting the capabilities of NX Advanced Simulation, NX Response Simulation produces a broad range of XY plot results and color contour results that aid the user in determining the integrity and suitability of product designs subject to dynamic loads. Analysis information can then be used to perform design studies to enhance the new product development process and ensure the quality of designs prior to physical prototyping and production.

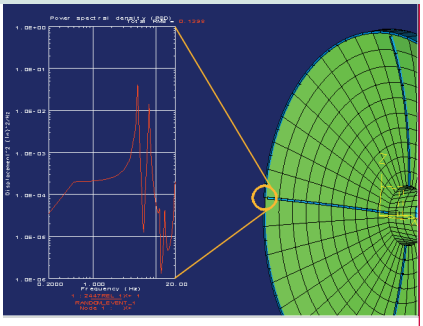
Benefits

- Provides insight to dynamic behavior
- Interactively evaluate the dynamic forced responses of a structural model
- Quickly generate and view results graphically

Features

- Perform multiple types of response analysis on structures
- Uses the very efficient modal method for response computation
- Leverages NX Nastran solver for the eigenvalue solution
- Simulate virtual tests with sensors
- Define loadings with analytical input or from test measurements
- Employ extensive XY plotting and contour display capabilities
- Provide mathematical, statistical and signal processing function operators
- Import, generate, sort, edit and manage a wide range of analytical data
- Compute, display and create reports on response functions and results
- Export response data to other analysis tools or model databases

A flexible way to predict responses



NX Response Simulation enables users to interactively evaluate the dynamic forced responses of a structural model. A set of flexible tools allows you to predict response of a model to a set of applied transient, frequency (harmonic), random vibratory or shock spectrum loads. A modal formulation is used to very efficiently calculate response using a prior solved set of mode shapes. The NX Nastran solver is used for solving mode shapes which are stored in a standard OP2 file format. Both normal modes and static modes for advanced methods are computed using the standard NX Nastran Basic package. Response Simulation attaches the OP2 file and extracts mode shape data as needed for simulating the wide range of dynamic analyses.

Response Simulation enables you to import, generate and edit the excitation information from CAE analysis or test data, including force, enforced motion and distributed loads (e.g., dynamic pressure). The user can then apply excitations to the structure, controlling dynamic modes, static corrections and damping assumptions to define an event for analysis. Motion, force and stress responses can be predicted as either XY plots at specific locations or as contour results over sections of the model or the complete model. Strength and peak results can be generated for elements by sorting through all time points or all frequencies for the maximum values. Extensive plotting and contour display capabilities allow results to be reviewed and compared with other data or allowables.

Generating a dynamics model

The first step is to develop a Nastran finite element model of the structure in review. NX Nastran models can be prepared using NX Advanced Simulation or any other FE pre/post-processing solution such as MSC.Patran, NX I-deas®, Hypermesh, etc. Model setup is consistent with standard Nastran modal solutions with the addition of parameter settings to output binary result (OP2) files from the NX Nastran solution, which are used as the basis of the interactive solution. Both normal modes and static modes for advanced methods are computed using the NX Nastran Basic package. The OP2 result files are imported into NX Advanced Simulation and used in the response simulation.

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Data processing tools

Export data to universal files (NX I-deas), RPC III files (MTS), DAC files (nCode), mat files (Matlab) and spreadsheet text files

Import data from spreadsheet text files

Perform mathematical and statistical processing and calculations

Manage, sort and edit an extremely high volume of functions in multiple files

XY graphics for display and probing

Convert functions between time domain and frequency domain (e.g., PSD functions)

Function tools

The function toolkit is part of the NX Advanced Simulation package and is used by NX Response Simulation both to define input loads and to store output results. Function tools in NX are used for plotting, managing and performing math operations and include scaling, offsetting, Fourier transform and interpolation. In addition to these tools, NX Response Simulation provides a set of operators that are specific to NX Response Simulation in a Java-based toolkit. These can be used, for example, to convert frequency domain PSD data to time domain transient (and vice-versa). One of the strengths of the Java application is that it is open so that users can define their own function operator if needed.

Interface to test

NX Response Simulation can be used to interface your analytical models with measured test data. With the toolkit functionality you can import test data. The measured test data can then be used as an input load. For example, measured accelerations could be used for a base excitation load. Another interaction with test is to compare analytical response predictions with measured responses. This verifies the accuracy of the model. To facilitate comparison of analytical responses with test data, NX Response Simulation has the concept of sensors. Sensor responses correspond to accelerometer measurements from a test. With sensors it is possible to compute response at many locations with one response request. Sensor responses can be computed for transient, frequency, PSD or FRF inputs. The sensor results can then be viewed overlaid with the corresponding test measurements.

A wide range of analysis types

Event type	*Description*
Transient	Calculates the dynamic response of a structure to a set of simultaneous excitations that vary over time. A transient excitation is either a point load (force or enforced motion) applied to a nodal degree of freedom or a distributed load. The software calculates the response at each instant in time. Examples of transient excitations include the time history of driving an automobile over a test track or any event in which a mechanical device is exposed to an excitation over a period of time.
Frequency	Calculates the steady-state responses of a structure to a set of simultaneous oscillatory excitations. A frequency excitation can be either a point load (force or enforced motion) applied to a nodal DOF or a distributed load. The software calculates the response at each frequency. Examples of frequency excitations include the effects on the driver's comfort in an automobile from engine vibration or wheel unbalance.
Random	Calculates the power spectral density (PSD), root mean square (RMS), and level crossing rate (LCR) results of a structure to one or more simultaneous random excitations. A random excitation can be a nodal force PSD function, an enforced motion PSD function (displacement, velocity, acceleration) or a distributed load.

Event type	*Description*
Response spectrum (also called shock response spectrum)	Calculates the peak response of a structure to a set of simultaneous base excitations defined by response spectrum functions. The peak response is calculated using modal combination methods (such as absolute method, square root of the sum of squares and others).
DDAM (dynamic design analysis method)	Calculates the dynamic response of a ship's components to shocks applied to the ship's hull, deck or plate mountings. The dynamic design analysis method was developed by the United States Navy. You can apply DDAM excitations for surface ships or submarines. You can apply these enforced motion excitations in vertical (Y), athwartship (Z) and fore/aft(X) directions. Available deformation types included elastic and elastic-plastic. Response Simulation uses U.S. Navy specification DDS-072-1. For confidentiality, the software allows you to enter the DDAM loading coefficients each time you preform the response evaluation. This way the coefficients are not stored. Alternatively, you can predefine and save the coefficients in a text file.

Excitations

Type of excitation	*Type of response analysis*
Distributed load	Transient, frequency, random vibration
Nodal force	Transient, frequency, random vibration
Base excitation and enforced motion (displacement, velocity, acceleration)	Transient, frequency, random vibration, response spectrum

Result output

Response format	*Type of analysis*	*Where generated*	*Response types*
Response function (for XY plots)	Transient, frequency, random vibration, FRF	At nodes, at nodes on elements, at element centroids	Displacement, velocity, stress, strain, acceleration, reaction force, shell stress resultants, element force and sensor
Response results datasets (for contour displays)	Transient, frequency	At given points in time: whole structure, selected nodes, selected elements. At given points in frequency: whole structure, selected nodes, selected elements	Displacement, velocity, acceleration, stress, strain, strain energy, shell stress resultants, and element force
Strength results datasets (for contour displays)	Transient, frequency, random vibration, response spectrum	For the whole event: whole structure or selected elements	Maximum dynamic stresses normalized by allowable values

Type of excitation		*Type of response analysis*	
RMS and level-crossing results* (for contour display)	Random vibration	Whole structure, selected nodes, selected elements	Displacement, acceleration, stress, shell stress resultants and element force
Peak value results** (for contour display)	Transient, frequency, response spectrum	Whole structure, selected nodes, selected elements	Displacement, acceleration, stress, shell stress resultants and element force

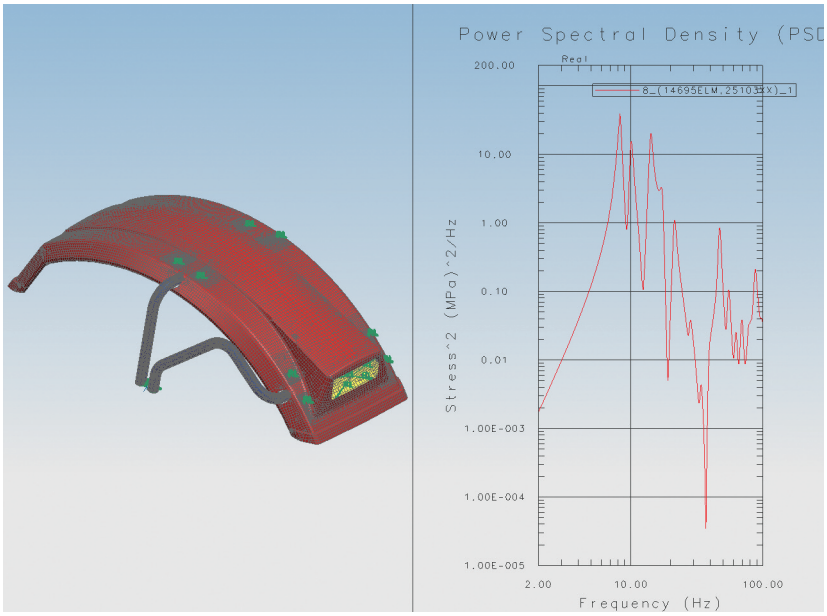
*Also calculates RMS and level-crossing rate of the von Mises stresses for dynamic stress analysis.

**Also calculates peak von Mises stresses for dynamic stress analysis.

Product availability

NX Response Simulation is an add-on capability in the suite of Advanced Simulation applications avialable within the NX architecture. It requires a core seat of either NX Advanced FEM or NX Advanced Simulation as a prerequisite. If used with NX Advanced FEM, a license of NX Nastran Basic (either Enterprise or Desktop) is also required. NX Advanced Simulation already includes the NX Nastran Desktop solver.

NX Response Simulation is available on most widely used hardware platforms and operating systems including Linux, Windows and Unix.



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