# NX Nastran – Aeroelasticity

**Predicting performance of structures operating in the presence of an airstream**

fact sheet

Siemens PLM Software

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## Summary

Aeroelastic analysis is a capability that enables the analysis of structural models in the presence of an airstream. With NX™ Nastran® – Aeroelasticity, an optional add-on module to NX Nastran – Basic software, you have access to static aeroelastic capabilities for stress, load, aerodynamic and control system analysis and design using a common finite element representation. As such, it is applicable in the design of airplanes, helicopters, missiles, suspension bridges and even tall chimneys and power lines.


### Benefits

Saves time and money by leveraging existing finite element models from NX Nastran – Basic

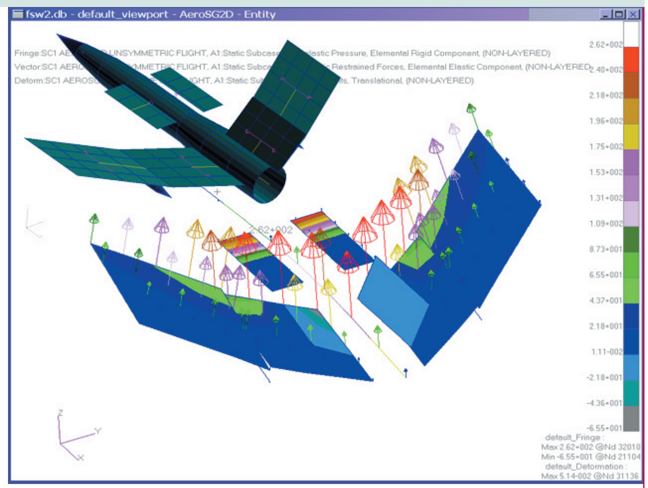
Takes advantage of convenient modeling available with dynamic loads applied in the time or frequency domains

Saves time by using an automated restart capability to independently investigate changes in structural or aerodynamic models

Improves user confidence by avoiding undesirable aeroelastic behavior, such as flutter

### Predicting results in presence of an airstream

When your design calls for predicting structural performance in the presence of an airstream, NX Nastran – Aeroelasticity can play a key digital simulation role. This product offers subsonic aeroelastic analysis capabilities, providing access to static aeroelastic capabilities for stress, load, aerodynamic and control system analysis and design using a common finite element representation.




### Major capabilities

*Comprehensive aeroelastic capabilities:*

Static aeroelastic trim analysis

- Aeroelastic stability derivative calculation
- Static aeroelastic divergence analysis
- Flutter analysis
- Aeroelastic dynamic response analysis, including:
  - Modal frequency response
  - Modal transient response
  - Random response analysis
- Design sensitivity and optimization for aeroelastic response

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## Features

Comprehensive aeroelastic capabilities

Suite of aerodynamic methods applicable across a range of Mach numbers

Specialized tools to automate aeroelastic analysis and design

Static aeroelastic feature that allows for stress, load, aerodynamic and control system analysis and design using a common finite element representation

Flutter analysis toolbox for performing critical analyses

Dynamic aeroelastic response that can be applied to a variety of unsteady loadings, including gust

Aeroelastic analyses for design sensitivity and optimization

*A suite of aerodynamic methods applicable across a range of Mach numbers:*

- Subsonic doublet lattice method, including body interference
- Strip theory, applicable at any Mach number
- Supersonic Mach box method
- Supersonic piston theory

Specialized tools automate aeroelastic analysis and design:

- Aerodynamic models are easily generated using specialized meshing procedures
- Splines link the aerodynamic and structural models
- Weighting matrices and correction factors can be used to alter the analytical aerodynamic predictions to match, e.g., wind tunnel test results
- Redundant controls and simplified control laws are available for quasi-static trim including scheduled control surfaces, hinge moment limits and control surface deflection limits
- Electronic control systems can be included in the stability and response analyses to investigate aeroservoelastic effects
- Automated restart features allow a simple and cost-effective way to independently investigate changes in the structural or aerodynamic models or to perform additional analyses without regenerating basic structural and aerodynamic matrices
- Supplemental analysis allows groups working in different organizations, companies and/or countries to generate analyses and integrate them readily into a full vehicle design

The static aeroelastic features allow for stress, load, aerodynamic and control system analysis and design using a common finite element representation:

- Aeroelastic deformations of the structure are considered in the determination of applied loads, internal stresses and stability derivative values
- Test results can be incorporated to refine the analysis
- Restrained stability derivatives, applicable in a flight simulator, or unrestrained derivatives, applicable to test results, are both available
- Rigid aircraft results are available to provide checks on the deformed results
- Control surfaces are easily modeled and analyzed for their performance characteristics in specified maneuver conditions and for their aeroelastic effectiveness as a function of Mach number and dynamic pressure
- Hinge moments are calculated for all control surfaces

A flutter analysis toolbox is available to perform critical analyses:

- Flutter analysis methods available include:
  The K-method is familiar to aeroelasticians and allows for general damping representations
  The KE method provides an “efficient” variation of the K-method for detailed flutter analyses
  The PK method provides realistic response estimates even when the system is not responding sinusoidally
- Control systems can be incorporated into the flutter analyses
- Oscillatory stability derivatives can be extracted from the generalized matrices

Dynamic aeroelasticity response can be applied to a variety of unsteady loadings including gust:

- One-dimensional gust loads are automatically computed and the aircraft response evaluated
- Dynamic loading can be applied in either the time or frequency domain with Fourier transform techniques used to convert time domain loads to the frequency domain and frequency domain responses to the time domain
- Store ejections and landing loads can be analyzed
- Random response analyses are available

Aeroelastic analyses are included in design sensitivity and optimization:

- A multidisciplinary capability is provided so that design conditions from static, normal modes and dynamic response analyses can be synthesized with aeroelastic responses
- Stability derivative values can be included in the design process
- Trim variable limits can be imposed in the design process
- Flutter damping levels can be used to preclude undesired flutter behavior
- The full design sensitivity and optimization capability outlined in the NX Nastran – Optimization fact sheet is available

### Table 1 – Analysis types in the aeroelastic module

| *Aeroelastic analysis types* | *Solution sequence* |
|---|---|
| Static aeroelastic analysis* | 144, 200 |
| Flutter analysis | 145, 200 |
| Dynamic aeroelastic analysis** | 146 |
| Aeroelastic design sensitivity | 200 |
| Aeroelastic optimization*** | 200 |

*Includes trip analysis, stability derivative computations and static aeroelastic divergence

**Includes frequency, transient and random response analyses

***Requires the optional Optimization module

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