MSC.Nastran Implicit Nonlinear

Finite Element Analysis of 3D Contact and Highly Nonlinear Problems

OVERVIEW
MSC.Nastran Implicit Nonlinear is a new capability for the analysis of highly nonlinear problems. MSC.Nastran Implicit Nonlinear provides 2 and 3D large sliding contact algorithms along with robust, user-friendly capabilities for the solution to all types of nonlinear problems including nonlinear material behavior, contact, large deformation/rotation, and finite strains.

This new capability will allow the user to perform a wide variety of nonlinear structural analyses using the existing input decks from the many thousands of existing MSC.Nastran models.

ANALYSIS SOLUTIONS

Linear Static
Nonlinear Static
• Adaptive load incrementation
• User specified load step control
• Convergence automation
Normal Modes (Eigenvalue Extraction)
Buckling Analysis
• Inverse power sweep
• Lanczos
Transient Dynamics
• Modal superposition
• Direct integration
• Adaptive or fixed time stepping
Creep Analysis
• Implicit or explicit
• Adaptive or fixed time stepping

CAPABILITIES
• Support for many analysis types
• Robust 2D and 3D sliding contact algorithms
• Handles highly nonlinear problems including large deflections, rotations, and strains
• Support for multiple analysis types
• Extensive element
• Extensive element library

BENEFITS
• Gain a better understanding of the nonlinear performance of your designs
• Extend the analysis that you can perform with your existing input decks
• Improve design quality by incorporating effects of contact

MSC.Software®
Simulating Reality
**ELEMENT LIBRARY**
These elements are modern, robust, accurate, and can handle large displacements, large rotations, and finite strains.

- truss
- axi-symmetric
- springs/dampers
- RBE
- gaps
- incompressible
- 2D laminated composites
- continuum composite

- beam
- plane strain
- generalized plane strain
- plate
- shell
- membrane
- gasket
- 3-D solid

**MATERIAL MODELS**
Most types of nonlinear materials are included in MSC.Nastran Implicit Nonlinear.

**Linear Elastic**
- Isotropic
- orthotropic
- anisotropic

**Elastic-Plastic**

**Rigid-Plastic**

**Perfectly Plastic**
- Multiple hardening rules
- Multiple yield criterion
- Strain hardening/softening
- Strain rate effects

**Elastomers**
- Nonlinear elastic in Total/Updated Lagrange framework
- Generalized Mooney-Rivlin model
- Ogden model
- Arruda-Boyce model
- Gent model
- Foam model - large strain compressible
- Large-strain viscoelastic model

**Creep**
- Deviatoric or volumetric strains
- Piecewise linear or exponential rate of equivalent creep strain

**Visco-elasticity**
- Maxwell and Kelvin models
- Isotropic materials

**Visco-plasticity**
- Combined plasticity and Maxwell creep model

**Composites**
- Laminated plates and shells
- Elastic-plastic behavior
- Arbitrary material orientations
- Relative ply angle for each layer
- Multiple failure criteria

**GENERAL CAPABILITIES**
MSC.Nastran Implicit Nonlinear contains support for the most commonly used nonlinear capabilities.

- Large Deformation and Finite Strain
- Total and updated Lagrange procedure
- Finite strain plasticity

**Automated Contact Analysis**
- 2-D and 3-D contact
- Discrete or analytical rigid contact
- Position and velocity control
- Load/Displacement control
- Multiple friction models
- Glued contact

**Parallel Processing**
- Manual Domain Creation
- Automatic Domain Creation

**Solvers**
- Direct profile solver
- Direct sparse solver
- Hardware sparse solver
- Multi-frontal sparse solver
- Iterative sparse solver
  - Diagonal
  - Incomplete Cholesky
- Nonsymmetric solver
- Double precision architecture
Loads and Constraint Creation
- Displacements
- Forces / Moments
- Pressure
- Heat source *
- Initial temperatures
- Initial stress
- Initial velocity
- Distributed load
- Temperatures
- Inertial loads
- Initial displacements
- Initial plastic strain

Contact Definition
Contact definitions are treated as boundary conditions. Each contact body is defined separately. No special elements are required or any contact pair definitions. By default all bodies may come in contact with each other and themselves. A contact table can control which bodies are allowed to come in contact and the contact interaction between individual bodies.
- Deformable bodies
- Rigid bodies
- Deformable-deformable contact
- Rigid-deformable contact
- Self contact
- Discrete or geometric (NURBS) definitions

Tying Support (multi-point constraints)

ANALYSIS SETUP AND CONTROL
Analysis jobs are initiated, monitored, and controlled just like standard MSC.Nastran jobs.

Analysis Load Step Creation
- Multiple analysis load steps submitted as separate sub-cases
- Load / Time-stepping procedures
- Convergence control / definition
- Contact table control
- Output request control
- General Analysis Control
- Selection of solver
- Restart control
- Standard Nastran job submission
- Job status file

POST-PROCESSING
MSC.Nastran Implicit Nonlinear provides standard .F06, .OP2, .PCH and .XDB output files for the visualization and interpretation of analysis results. Users have the option to retain the MSC.Marc™, .STS, .OUT and .T16/19 files.

Results Access
Import of MSC.Nastran .XDB or .OP2 file into MSC.Patran™
Direct results access (DRA) of .XDB or .T16/19 files (results remain in results file – not imported into MSC.Patran database).

* indicates that this feature is not in the first release.