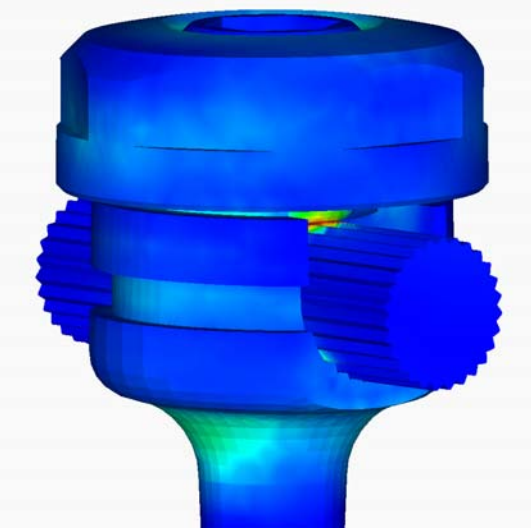
NEi Nastran

Module NE-L4 (Nonlinear Analysis)

Overview

This module allows the user to analyze structures that exhibit nonlinear behavior. Nonlinear effects can be created due to nonlinear material properties, large deformations and changes in the boundary conditions resulting from contact. Since most physical phenomena contain some kind of nonlinear effect the power and utility of this module is obvious.



Capabilities:

Material Nonlinear:

- Plasticity
  - Von Mises, Tresca, Mohr-Coulomb and Drucker-Prager yield criteria
  - Isotropic, kinematic, and combined hardening
  - Temperature dependent bilinear or multiple point stress-strain curves
- Nonlinear elasticity
- Large strain hyperelastic
  - Neo-Hookean
  - Mooney-Rivlin
  - Yeoh
  - Ogden
  - Generalized Polynomial
- Large strain isotropic
- Thermo-elasticity
- Temperature dependence
- Creep
- Brittle materials – concrete
- Shape memory material (Nitinol)

Geometric Nonlinear:

- Large displacements and rotations (updated Lagrangian)
- Follower forces
- Snap-through analysis
- Displacement control

Contact:

- Gap
  - Adaptive stiffness update
  - Allows friction
- Slide Line
  - Allows translation and rotation in 2-dimensions
  - Permits modeling of problems that are not possible with gap elements (2D sliding)
  - Adaptive stiffness update
  - Allows friction
- Surface-to-Surface
  - Completely automatic surface contact generation
  - General, welded, rough, and bidirectional-slide contact
  - Allows translation and rotation at the same time
  - Permits modeling of problems that are not possible with gap or slide line (3D sliding)
  - Adaptive proximity or displacement based stiffness update
  - Allows friction
  - Quick and simple to setup, no need to align nodes or elements
  - Controls over initial penetration and stiffness
- All contact elements (gap, slide line, and surface-to-surface contact) support friction

Nonlinear Composites:

- Progressive Ply Failure Analysis for Nonlinear Static and Transient solutions (PPFA)*
- Helius:MCT Ply Failure integration*
- Adaptive Nonlinear Static and Transient Analysis
- Temperature dependent composites material properties

- **Tension Only:**
- Cable
  - Allows initial slack or preload
  - Ultimate tensile stress can be specified above which the cable fails
  - Supports temperature dependent material properties
  - Supported in all solutions
- Shell Element
  - Tension only membrane reverts to a shear panel in compression
  - Option to dump extensional loads in quad elements into adjacent line elements
  - Designed for analyzing semi-monocoque aircraft structures
  - Controllable compression stiffness scale factor
- Multiple loading conditions
  - Nonlinear application of load increment
  - Optional reset allows multiple loading conditions that are independent of the previous subcase

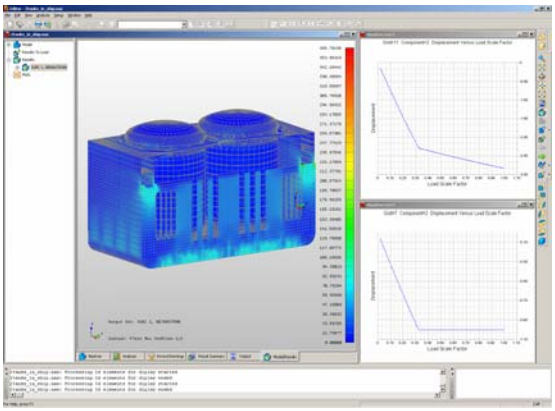
Direct Nonlinear Solutions (No Restarts Required):

- Nonlinear Buckling
- Nonlinear Prestress
  - Modal
  - Buckling
  - Dynamics (requires NE-L3)
    - Transient Response
    - Frequency Response
    - Random Vibration
    - Response/Shock Spectrum Generation
    - Modal Summation
- Nonlinear Transient Response (Event Simulation) (requires NE-L3)

* Additional license required

Automated Solutions Tools:

- Adaptive
  - Bisection and recovery of load increment
    - Iteration acceleration and damping
    - Line search
  - Correction for path reversal
  - Time stepping
    - Automatic bisection
    - Automatic stiffness update
  - Contact elements
    - Gap
    - Slide line
    - Surface-to-surface
- Combined load-displacement control method



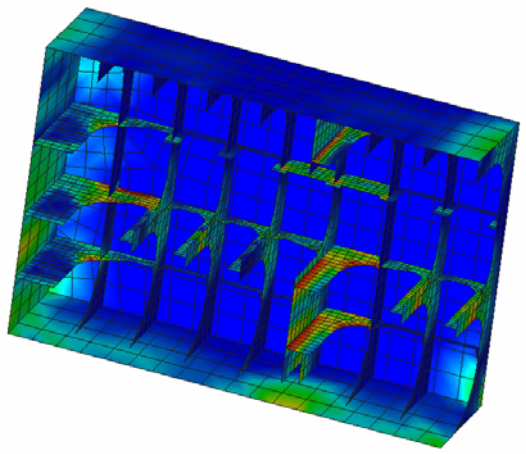
- Arc-length methods
  - Crisfield
  - Riks
  - Modified Riks
- Stiffness updates for unloading
- Implicit Newmark-Beta time step integrator
- Automated Surface Contact Generation (ASCG)
- Automated Impact Analysis (AIA)

Global Matrix Output:

- Linear stiffness matrix
- Tangent stiffness matrix
- Mass matrix

Direct Matrix Input Grid (DMIG) Support:

- Stiffness matrix import and export
- Mass matrix import and export
- Damping matrix import and export
- Load vector import and export



Model Reduction:

- Static condensation
- Export reduced stiffness matrix using DMIG format

Full Analysis Compatibility:

- Linear analysis model can be easily extended to nonlinear analysis
  - Add only the nonlinear specific entries
- All elements can be included
- Similar output formats
- User definable restart capability for nonlinear static analysis

Visualization in the Editor:

- Maximum displacements, stresses, etc. can be tracked as a function of loading
- View results real-time as they change for each load increment or time step
- Change nonlinear parameters real-time
- Generate dynamic plots automatically during nonlinear analysis
- Generate x-y plots real-time and store as MS Excel Comma Separated Variable (.CSV) files
- Generate multiple plots with a single command
- Custom x-y plotting of results

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For more information about our company or our products, please contact:

Headquarters:

NEi Software, Inc.
5555 Garden Grove Blvd., Suite 300
Westminster, CA 92683-1886
USA
Phone: +1.714.899.1220
Fax: +1.714.899.1369
Email: info@neisoftware.com
Website: www.NEiSoftware.com

Europe:

NEi Software EMEA Office
The Old Barrel Store
Draymans Lane, Marlow
Buckinghamshire, SL7 2FF
United Kingdom
Phone: +44.0.1628.400.645
Fax: +44.0.1628.891.701
E-mail: emea@neisoftware.com
Website: www.NEiSoftware.com/emea

Asia:

NEi Software Asia Office
Shinjuku Park Tower
N30th Floor 3-7-1 Nishi-Shinjuku
Shinjuku-ku, Tokyo, 163-1030
Japan
Phone: +81.03.5326.3062
Fax: +81.03.5326.3001
E-mail: asia@neisoftware.com

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