ANSYS Structural Mechanics

Advanced Structural Mechanics for All Stages of Product Development

Structural mechanics solutions from ANSYS provide the ability to simulate every structural aspect of a product, including linear static analyses that simply provides stresses or deformations, modal analysis that determines vibration characteristics, through to advanced transient nonlinear phenomena involving dynamic effects and complex behaviors.

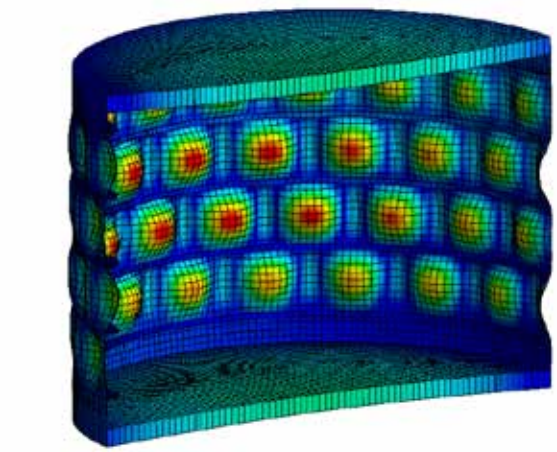
All users, from designers to advanced experts, can benefit from ANSYS structural mechanics solutions. The fidelity of the results is achieved through the wide variety of material models available, the quality of the elements library, the robustness of the solution algorithms, and the ability to model every product — from single parts to very complex assemblies with hundreds of components interacting through contacts or relative motions.

ANSYS structural mechanics solutions also offer unparalleled ease-of-use to help product developers focus on the most important part of the simulation process: understanding the results and the impact of design variations on the model.

High Fidelity Simulations

ANSYS offers a broad range of structural mechanics analysis types:

- Static analysis with or without nonlinearities for stress and deformation evaluation
- Dynamic analysis ranging from simple determination of vibration characteristics (eigenmode, harmonic or spectrum analysis in the frequency domain) to complex time-dependent transient phenomena, including dynamic effects and time-dependent material properties
- Steady-state or transient thermal analysis that can be efficiently coupled to subsequent stress analyses



Post-buckling analysis of a ring-stiffened cylinder

Product Features

Structural Analysis
- Static analysis
- Modal analysis
- Harmonic analysis
- Transient analysis
- Spectrum analysis
- Buckling analysis

Geometric Nonlinearity
- Large strain
- Large deflection
- Stress stiffening
- Spin softening
- Coriolis effects

Contact Definitions
- Surface-to-surface
- Node-to-surface
- Node-to-node
- Beam-to-beam
- Beam-to-surface
- Deformable – deformable
- Deformable – rigid

Contact Formulations
- Penalty
- Augmented Lagrange
- Assembly contact (MPC)
- Lagrange multiplier
- Mixed Lagrange and penalty

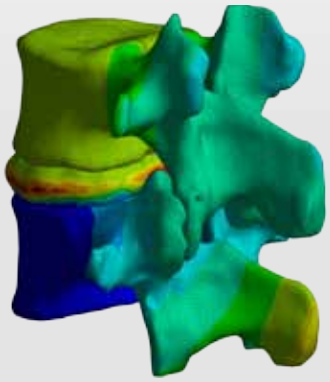
Contact Properties
- Contact with friction
- Thermal contact
- Electric and magnetic contact
- Spot welds

Boundary Conditions
- Solid and FE model BCs
- Initial conditions
- Tabular and function loads
- Structural and thermal loads
- Prestress loads

Material Modeling
- Linear elasticity

Product Features

- Inelastic
  - Rate independent
  - Rate dependent
  - Nonmetal plasticity
  - Shape memory alloys
  - Cast iron
- Hyperelasticity (isotropic/anisotropic)
- Viscoplasticity and viscoelasticity
- Creep and swelling
- Piezoelectric
- Density, specific heat, thermal expansion
- Thermal and electric conductivity
- Material damping
- User materials
- Temperature-dependent properties
- VCCT



Structural analysis of a human vertebra subassembly

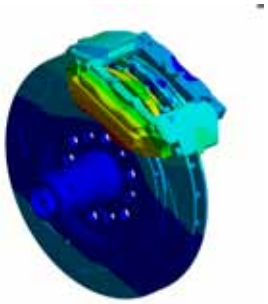
Image courtesy Materialise NV.

Element Technology

- 2-D, 3-D structural solids
- 2-D, 3-D thermal solids/shells
- Structural shell elements
- Structural beam elements
- Structural pipe elements
- Structural solid shell elements
- Generalized 3-D axis-symmetric elements
- Gasket elements
- Elbow elements
- Pore-pressure elements
- Coupled-physics elements
- 2-D, 3-D surface effect
- Spring/dashpot elements
- Joint elements
- Rebar/reinforcement elements
- User elements

Advanced and specialized models are available for:

- Composites structure modeling
- Analysis of rotating machines (rotordynamics)
- Mechanism analysis mixing rigid and flexible bodies
- Linear and nonlinear buckling
- Cyclic symmetry models
- Fracture mechanics



Modeling Complex Material Behavior

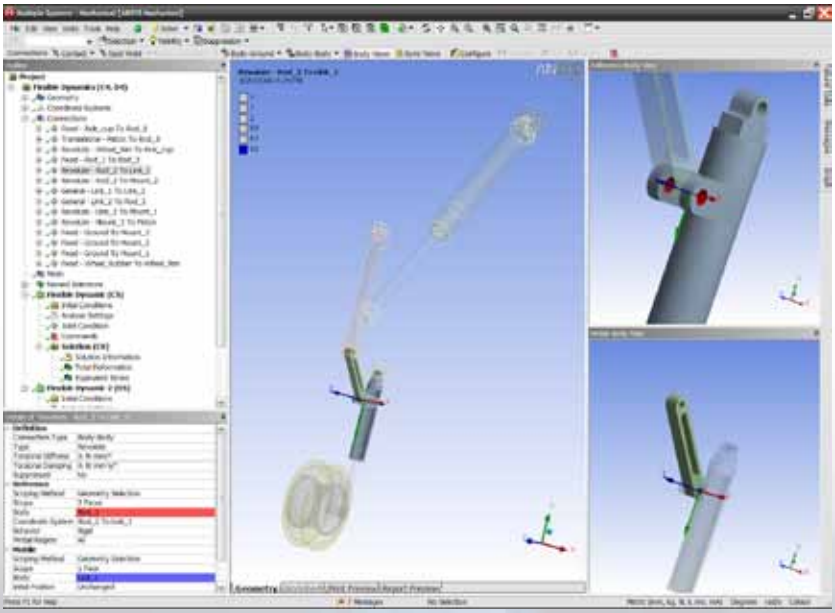
To help users obtain accurate results, ANSYS solutions provide an extensive library of material models: linear and nonlinear material models to handle composites, plasticity in metals, and hyperelasticity of rubber components as well as specialized materials including cast iron, shape memory alloys, porous elasticity and cohesive zone models used to simulate debonding between parts.

Modeling All Topologies

To represent complex real-world geometries, ANSYS structural mechanics solutions offer support for a range of elements including beam, shell, solid and solid-shell elements. Also available are pretension, joints, gaskets and other special elements including nonlinear springs or smeared and discrete reinforcements.

Modeling Interaction between Parts

Because simulated or real products usually involve multiple parts that interact, a robust and complete set of contact capabilities is available: surface–surface, line–surface and line–line contact for flexible and rigid bodies; contact behavior for constant or orthotropic friction;



The modern, easy-to-use interface of the mechanical application in the ANSYS Workbench platform has advanced tools like automatic joint-detection seen in this aircraft landing gear assembly

ANSYS®

and sliding behavior for structural, thermal and multiphysics contact applications. Fast, automatic contact detection backed by powerful algorithms allows for fast and accurate solving of models involving contacts.

Ease of Use — Even for Advanced Simulations

The mechanical simulation interface based on the ANSYS® Workbench™ platform enables users to model all applications, from very simple to highly complex. The interface can take weeks out of a computer-aided engineering (CAE) process by eliminating manual file transfer as well as result– translation and re-analysis time.

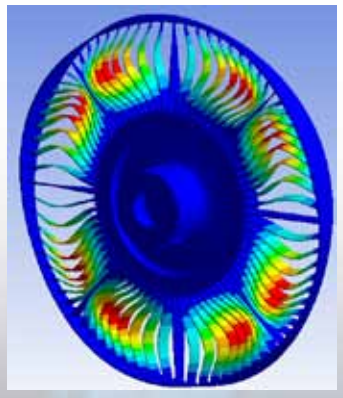
Within the highly productive ANSYS Workbench environment, users can benefit from very advanced technologies:

- Bidirectional link to all major CAD systems, removing the need for model repair and providing automated model updates upon design changes
- Automatic meshing capabilities for all geometries (1-D to 3-D)
- Automatic contact detection, no matter the number of parts
- Comprehensive post-processing for in-depth analysis of the design user elements
- Automatic generation of simulation reports with all technical data and user-defined figures
- Knowledge capture through wizards and templates
- Parametric capabilities to automate and simplify sensitivity or optimization studies

Advanced Techniques to Solve Larger Problems Faster

Current trends in simulation show an increased need for the efficient computation of large models. With Distributed ANSYS, the entire solution phase runs in parallel, including stiffness matrix generation, linear-equation solving and results calculations in both shared and distributed memory processing.

Additional advanced techniques such as component mode synthesis (CMS), submodeling techniques and proprietary acceleration techniques, aid in efficiently handling large models.



Cyclic symmetry analysis of turbine blades

Product Features

Thermal Analysis
- Steady-state and transient
- Conduction
- Convection
- Radiation
- Phase change
- Mass transport
- Fluid elements

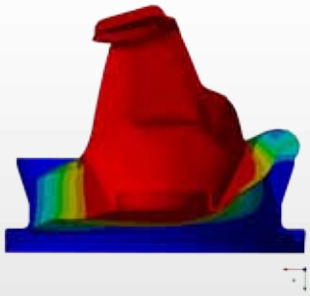
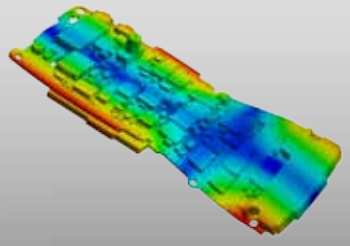


Image courtesy ZF Boge Elastmetall.

Coupled Physics
- Thermal – structural
- Acoustic – structural
- Thermal – electric
- Piezoelectric
- Acoustics

Optimization
- Design optimization
- Topological optimization
- Probabilistic design
- Parametric simulation

ANSYS Parametric Design Language
- If–then–else constructs
- Do-loop features
- Array parameters
- Array parameter operations
- Macros
- Trigonometric functions
- Parametric modeling

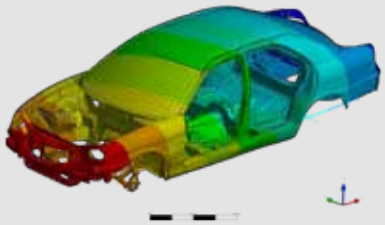


Product Features

Additional Features
- Cyclic symmetry analysis
- Rotordynamics
- Rigid/flexible multibody dynamics
- Submodeling
- Adaptive meshing
- CMS
- Substructuring
- 2-D rezoning (hyperelasticity/plasticity)

Solvers
- Iterative
- Sparse direct
- Distributed sparse
- Distributed PCG
- Distributed JCG
- Eigensolvers
- Block Lanczos
- Subspace
- Reduced
- QR-damped
- Unsymmetric
- LANPCG
- SNode

Additional Modules
- ANSYS DesignModeler™
- ANSYS DesignXplorer™
- ANSYS Fatigue™
- ANSYS Rigid Dynamics
- ANSYS Mechanical™ HPC



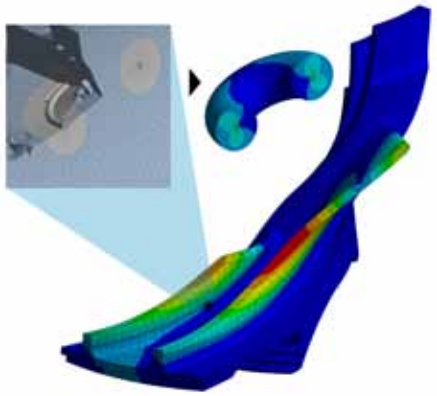
Parametric Capabilities for Better Design Understanding

The parameterization capabilities of ANSYS structural mechanics solutions allow users to easily iterate on design changes. Product developers can perform design analysis studies and optimization at a very low cost in terms of user time.

As a result, simulation users become part of the design process, since the results of their analyses allow them to answer what-if questions, guiding the process toward better and innovative solutions.

A Scalable Solution

ANSYS offers a range of products that help users to meet current requirements as well as plan for seamless future upgrades.



Crack-Tip analysis of an impeller blade with a hex-dominant and an embedded penny crack mesh for failure evaluation due to fracture
Courtesy of PADT Inc.

Tailoring the Solver to the User's Needs: Customization and Scripting

Customization through user-defined elements and user materials provides the flexibility to extend the capabilities of ANSYS structural mechanics solutions for a wide range of applications. Advanced users can benefit from ANSYS Parametric Design Language (APDL), which provides a rich set of scripting capabilities to perform entire simulations from pre-processing to post-processing, to automate processes or to access advanced features and solver settings.

The ANSYS Advantage

With the unequalled depth and unparalleled breadth of ANSYS engineering simulation solutions, companies are transforming their leading edge design concepts into innovative products and processes that work. Today, almost all of the top 100 industrial companies on the "FORTUNE Global 500" invest in engineering simulation as a key strategy to win in a globally competitive environment. They choose ANSYS as their simulation partner, deploying the world's most comprehensive multiphysics solutions to solve their complex engineering challenges. The engineered scalability of solutions from ANSYS delivers the flexibility customers need, within an architecture that is adaptable to the processes and design systems of their choice. No wonder the world's most successful companies turn to ANSYS — with a track record of 40 years as the industry leader — for the best in engineering simulation.

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