



## Structural Mechanics Solutions

### 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

### Structural Mechanics Solutions for Better Designs and Shorter Design Cycles

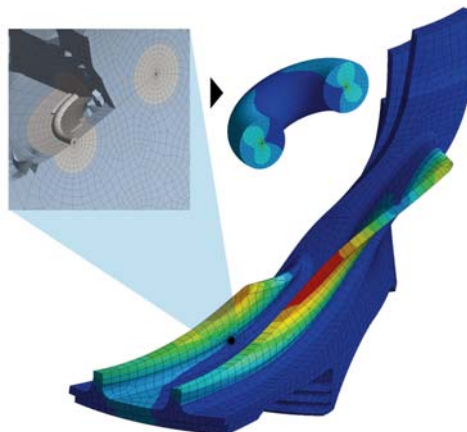
To stay competitive, meet customer demands and develop innovative and reliable products in ever-shortening design cycles, designers and engineers require simulation tools that offer best-in-class integrated solutions. ANSYS structural mechanics solutions offer simulation tools to solve challenging engineering problems and create better products.

#### Functionality that Meets the Needs of Today's Industries

ANSYS structural mechanics solutions offer products and capabilities that meet the demands of today's industries with:

- **Better design through innovation:** Advanced analysis capabilities offer better insight into product design and performance, leading to increased quality, lower costs and fewer rejected products.
- **Lower costs and shorter cycles:** Tighter product integration between geometry, meshing, simulation and optimization offers a one-stop solution for end users with reduced software training costs and shorter development cycles.
- **Optimized solutions and less prototyping:** The parameterization capabilities of ANSYS structural mechanics solutions allow users to easily iterate on design changes. Design analysis studies and optimization are available.

The ANSYS structural mechanics family of products offers an unequalled depth of analysis from concept simulation to advanced analysis; its unparalleled breadth of simulation capabilities ranges from linear to nonlinear coupled-physics analysis. With a full complement of linear and nonlinear elements, material laws ranging from metal to rubber and the most comprehensive set of solvers available, ANSYS simulation tools are applied widely across industries by users, from design engineers to advanced analysts. Additionally, the adaptive architecture of ANSYS software tools provides you with the flexibility for customization and interoperability with other tools such as in-house codes or third-party software.

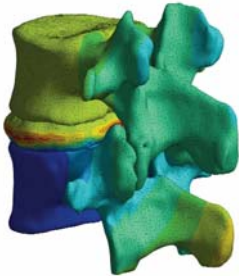


**Crack-tip analysis of an impeller blade with a hex-dominant and an embedded penny crack mesh for failure evaluation due to fracture**  
*Courtesy of PADT Inc.*

## Features

### Material Modeling

- ▶ Linear elasticity
- ▶ Inelastic
  - Rate independent
  - Rate dependent
  - Non-metal 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



**Structural analysis of a human vertebra subassembly**

Image courtesy Materialise NV

### Element Technology

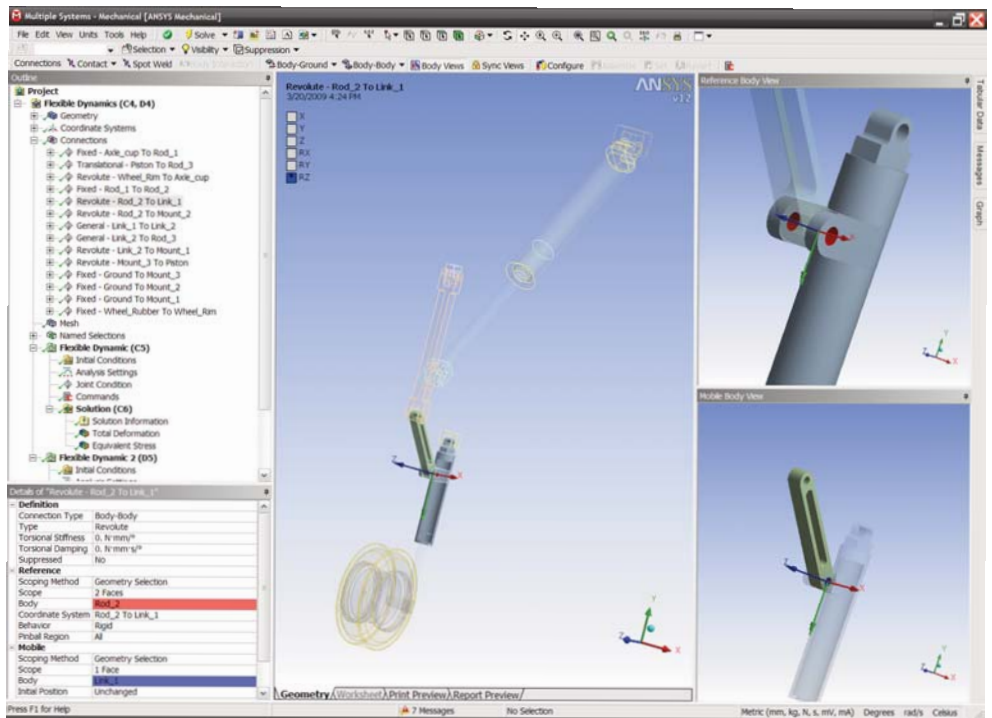
- ▶ 2-D, 3-D structural solids
- ▶ 2-D, 3-D thermal solids/shells
- ▶ Structural shell elements
- ▶ Structural beam elements
- ▶ Structural pipe elements
- ▶ Structural solid shell elements
- ▶ Generalized 3-D axis-symmetric elements
- ▶ Gasket elements
- ▶ Elbow elements
- ▶ Pore-pressure elements
-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

## Faster and Better Designs with ANSYS Structural Mechanics Solutions

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

Within this highly productive environment, the user will benefit from very advanced technologies:

- **Superior CAD integration**  
Parameters, bidirectional link to all major CAD systems
- **Automatic contact detection**  
Large assemblies, mixed shell-solid-beams, joints
- **Customization and scripting**  
GUI customization, ANSYS® Mechanical™ APDL user mat, user elements
- **Knowledge capture**  
Wizards, templates, project schematics
- **Automatic meshing capabilities**  
Tetra, sweep-hex, shell, thin-solid, hex-dominant
- **Advanced solver capabilities**  
Sparse, iterative, supernode, distributed HPC
- **Comprehensive post-processing**  
Custom results, linearized stress, path plots, etc.
- **Automatic reports**  
Integrated reporting, PowerPoint, Word, HTML



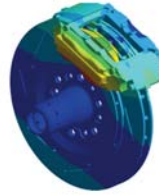
The modern, easy-to-use interface of the mechanical application in the ANSYS Workbench platform has advanced tools like automatic joint-detection seen in this aircraft landing gear assembly.

## Unparalleled Breadth of Capabilities to Simulate Any Mechanical Model

ANSYS structural mechanics solutions offer a broad spectrum of capabilities covering a range of analysis types, elements, contact, materials, equation solvers and coupled physics all targeted toward providing insight into, and solving, complex design problems.

### Modeling Operational Conditions: A Wide Variety of Analysis Types

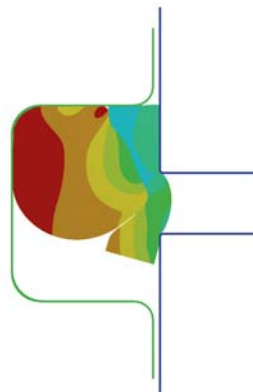
The ANSYS structural mechanics software portfolio offers a variety of analysis capabilities such as static, modal, harmonics and transient, and linked analysis types such as prestressed modal, brake squeal and random vibration analysis.



### Vast Library of Elements, Materials and Contact Solutions

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. In addition, pre-tension, joints, gasket, rebars/reinforcements and other special elements are available
- A range of linear and nonlinear material models to handle composites, plasticity in metals, hyperelasticity of rubber components and specialized materials including cast iron, shape memory alloys, porous-elasticity and cohesive zone models
- A robust and complete set of contact capabilities for surface-surface, line-surface and line-line contact for flexible and rigid bodies; contact behavior can account for constant or orthotropic friction as well as sliding behavior and is applicable 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
- Simulations also can be extended to a set of comprehensive multi-physics capabilities including thermal-stress, electro-mechanical, structural-acoustics, mass diffusion and thermal-fluid analysis



Displacement plot of a high performance seal

### Advanced Modeling

ANSYS structural mechanics solutions offer advanced modeling for rotordynamics applications, flexible multibody dynamics, adaptive meshing and 2-D rezoning.

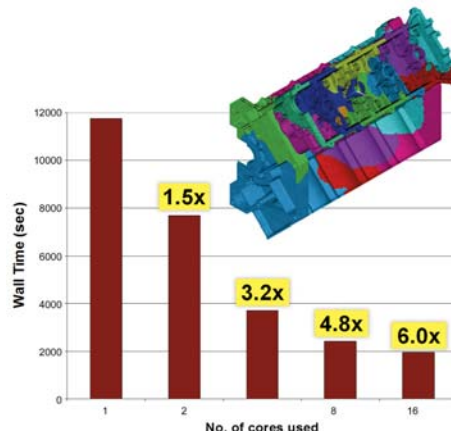
### Tailoring the Solver to the User's Needs: Customization and Scripting

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 also benefit from ANSYS Mechanical APDL provides a rich set of scripting capabilities to perform entire simulations from pre-processing to post-processing, automate processes or access advanced features and solver settings.

### Solving Large Models Efficiently

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 like component mode synthesis (CMS), cyclic symmetry analysis and submodeling techniques also help to handle large models efficiently.



ANSYS Release 12 extends scalability of distributed solvers from desktop workstations to large-size clusters

### Features

#### Thermal Analysis

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

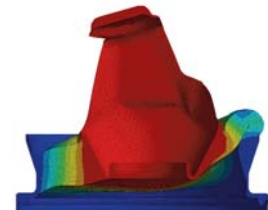


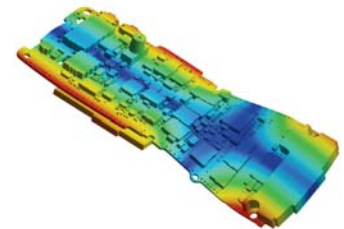
Image courtesy ZF Boge Elastmetall

#### Coupled Physics

- Thermal-structural
- Acoustic-structural
- Thermal-electric
- Piezoelectric
- Acoustics

#### Optimization

- Design optimization
- Topological optimization
- Probabilistic design
- Variational technology
- Parametric simulation



#### ANSYS Mechanical APDL

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

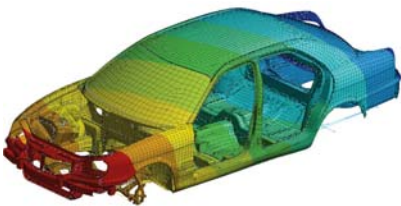
## Features

### Additional Features

- ▶ Cyclic symmetry analysis
- ▶ Rotordynamics
- ▶ Flexible multibody dynamics
- ▶ Submodeling
- ▶ Adaptive meshing
- ▶ CMS
- ▶ CMS for large rotations
- ▶ Substructuring
- ▶ 2-D rezoning (hyperelasticity/plasticity)
- ▶ Rigid-body dynamics (ADAMS) interface

### Solvers

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



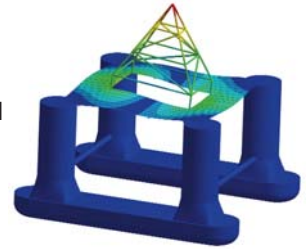
### Additional Modules

- ▶ ANSYS® DesignModeler™
- ▶ ANSYS® DesignXplorer™
- ▶ ANSYS Rigid Dynamics
- ▶ ANSYS Mechanical HPC
- ▶ ANSYS® Fatigue™

## Engineered Scalability

ANSYS structural mechanics solutions offer a range of products that help users meet current requirements and plan for a seamless upgrade path for future needs.

**ANSYS® Mechanical™** software offers a comprehensive product solution for structural linear/nonlinear and dynamics analysis. The product offers a complete set of elements behavior, material models and equation solvers for a wide range of engineering problems. In addition, ANSYS Mechanical software offers thermal analysis and coupled-physics capabilities involving acoustic, piezoelectric, thermal-structural and thermal-electric analysis.



Linear dynamic analysis of a semi-submersible

**ANSYS® Structural™** software addresses the unique concerns of pure structural simulations without the need for a large number of extra tools. The product offers all the power of its nonlinear structural capabilities — as well as all its linear capabilities — in order to deliver the highest quality, most reliable structural simulation results available.

**ANSYS® Professional™** software offers a first step into advanced linear dynamics and the nonlinear capabilities of mechanical solutions from ANSYS. Two versions of ANSYS Professional are available: ANSYS Professional NLT with linear structural and dynamics capabilities and a nonlinear thermal capability, and ANSYS Professional NLS with linear structural dynamics and thermal capabilities as well as a basic structural nonlinear capability.

**ANSYS® DesignSpace®** is an easy-to-use simulation software package that gives designers tools to conceptualize, design and validate all their ideas right on the desktop. ANSYS DesignSpace software, a subset of the ANSYS Professional product, enables users to easily perform real-world static structural, thermal, dynamic, weight optimization, vibration mode and safety factor simulations without the need for advanced analysis knowledge.

Our solutions allow knowledge transfer from experienced analysts to less experienced while maintaining high-quality simulation standards. Whether from a one-man company or a large-scale enterprise, ANSYS structural mechanics solutions allow users to adapt the technology to their needs.

## The ANSYS Advantage

With the unequalled depth and unparalleled breadth of our engineering simulation solutions, companies are transforming their leading edge design concepts into innovative products and processes that work. Today, 97 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 our solutions 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 almost 40 years as the industry leader — for the best in engineering simulation.