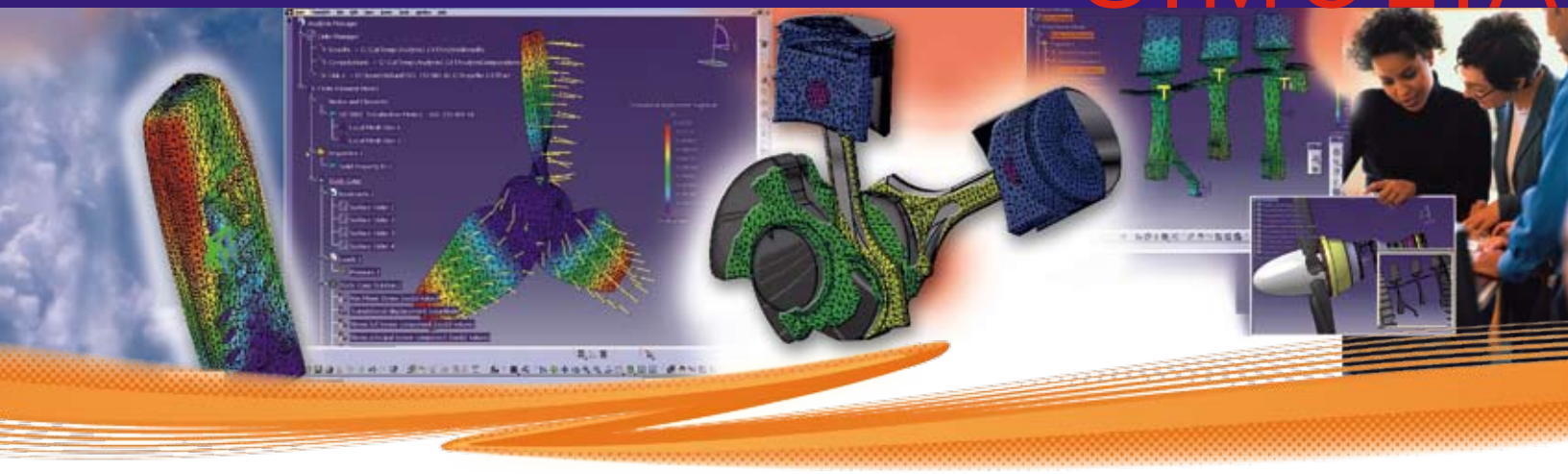


Nonlinear Structural Analysis (ANL)

Extends the capabilities of CATIA V5 Analysis to basic nonlinear analysis

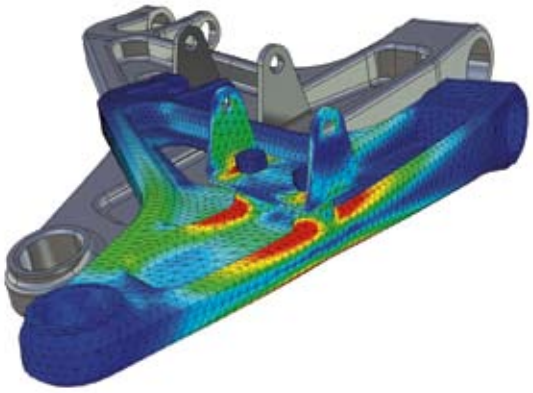
Overview

Nonlinear Structural Analysis (ANL) extends the CATIA V5 Analysis capabilities to allow more advanced simulation that includes nonlinear effects, such as large displacements and material nonlinearity. Material plasticity, typical of metals, can be modeled, as can the nonlinear elasticity in hyperelastic materials like rubber. ANL also provides more advanced contact capability including the automatic creation of contact surfaces based on their geometric proximity.

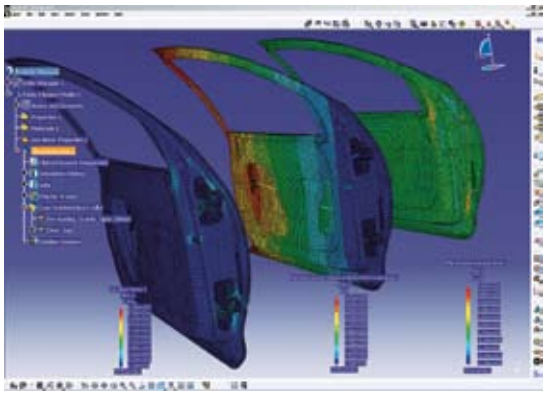
ANL allows designers and design engineers to understand the performance of components that are made of materials like rubber that have nonlinear responses. In such scenarios, the designs are flexible and undergo large displacements, or they sustain overload conditions when components might be permanently deformed, but must not fail.

Product Highlights

- Includes the effect of large displacements.
- Allows the plastic deformation of materials to be modeled.
- Models the nonlinear elasticity of rubber and other hyperelastic materials.
- Multi-step analysis allows the effect of multiple sequential loadings to be analyzed.
- Provides advanced contact capability including automatic contact detection.
- Performs thermal stress analysis when used in conjunction with Thermal Analysis (ATH).



Nonlinear and multi-step stress analysis plays an important role in verifying whether the design of this control arm suspension assembly is suitable or requires further revision.



Static analysis of a door sag. As the door undergoes large deformation, it is fundamental to consider geometric nonlinearity for the relevance of the design decision.

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Features and Benefits

In addition to the functionalities and benefits provided by Generative Part Structural Analysis (GPS), Nonlinear Structural Analysis (ANL) offers:

Basic nonlinear structural analysis

GPS and GAS assume that the response is linear—that the material is linear elastic, that the displacements are small, and that any sliding of surfaces in contact is also small. ANL removes these limitations. It can model the effects of geometric nonlinearity, such as large displacements, and allows nonlinear materials to be included, such as the yielding of metals and nonlinear elastic materials like rubber. It also offers more advanced contact capabilities than GAS, including the ability to model large relative sliding of surfaces in contact.

Nonlinear materials

In addition to isotropic and orthotropic elasticity, ANL can model nonlinear hyperelastic materials like rubber. A number of different mathematical models, such as Mooney-Rivilin, neo-Hookean, and Ogden, are available depending on the level of accuracy required and the amount of material test data available. The plasticity of metals can be modeled and a number of different hardening models are available, including isotropic hardening for general use and kinematic hardening for low cycle fatigue studies. The material properties can be temperature-dependent when performing a thermal stress analysis in conjunction with Thermal Analysis (ATH).

Multi-step analysis

ANL enables the effect of multiple steps to be analyzed, where the loading, restraints, contact conditions, etc., vary from one step to the next. This powerful technique allows complex loading sequences to be modeled. For example, a pressure vessel might be subjected to an initial bolt tightening step, followed by internal pressurization, and conclude with thermal loading.

Vibration analysis

In addition to nonlinear static analysis, ANL can also calculate the natural frequencies and associated mode shapes. In a multi-step analysis, a step that computes the modes and frequencies of the structure can be included at any point in the loading sequence. Previous loading is important because the natural frequencies can change significantly during deformation as the structure experiences changing loads, boundary conditions, temperature, and contact conditions.

Loading

Concentrated forces and moments can be applied at points, pressure loads can be applied to surfaces, and gravity loads can be applied to volumes. The loading can vary over the course of the analysis by referencing an “amplitude.” The loading will follow the motion of the component if it undergoes large displacements or rotations.

Advanced contact

ANL offers more advanced connection capability than what is available in GAS. The “Find Interactions” wizard automatically detects pairs of surfaces that will likely come into contact during the analysis, making it easy to set up contact analyses for assemblies. Contacting parts can undergo large relative sliding, which may include frictional effects. Self-contact, where a part deforms so much that it contacts itself, can also be included. A number of options are available to make it easier to solve complex contact problems and to ensure that accurate results are obtained. These include contact stabilization, automatic surface adjustment, softened contact, the ability to change the contact algorithm (Lagrange, augmented Lagrange, or penalty), and the ability to accurately specify the initial clearance between surfaces.

Connections

A variety of connections can be modeled, such as bolts, springs, and welds. The bolt modeling capability ensures the easy modeling of bolted connections to accurately simulate bolt loads. The spot, seam, and surface weld modeling tools allow a large number of flexible or rigid fasteners to be modeled in just a few steps. Other types of available connections include rigid connections, virtual parts, and nonlinear springs.

Robust, efficient solution

ANL uses a state-of-the-art sparse solver that computes the results rapidly while minimizing the amount of memory consumed. It takes full advantage of the additional memory available in 64-bit computers allowing the solution of very large models. A non-symmetric solution is adopted automatically if the problem requires it. Modes and frequencies are calculated using a high-performance Lanczos solver.

Nonlinear structural analysis is performed using an iterative technique that is very robust and requires little user interaction. Load incrementation and convergence is automatic and adaptive and ensures accurate results. Interactive diagnostics help users quickly understand and correct modeling problems.

Results interpretation

ANL allows additional results to be plotted (including plastic strain), which can be used as an estimate if failure were to occur. Data can be exported to Excel—for example to study how the displacement, stress, or strain at a point varies over the course of the analysis.

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