

**Realize Your Product Promise™**

**ANSYS®**

**Composites**



Composite-based surfboard

## Innovate with novel composite materials by engineering layered structures for even the most complex products.

You can incorporate efficiency and certainty into your composite formula with ANSYS Composite PrepPost.

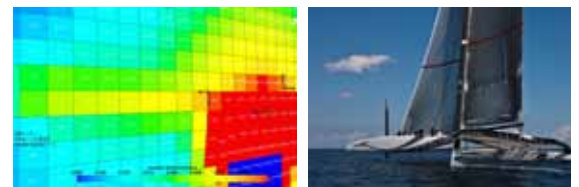
Composites blend two or more materials that possess very different properties. Because they combine light weight, high strength and outstanding flexibility, composites have become standard materials for manufacturing a range of products, including complex-shaped products such as boat hulls and surfboards.

These composites pose many challenges for R&D teams that need to identify the appropriate formulation for a required use. To successfully engineer layered composites, you must define the optimal material formula — which depends on the number of layers involved along with the thickness and relative orientation of each layer.

The challenge is to predict how well the finished product will perform under actual working conditions. This involves considering everyday stresses and deformations as well as a range of failure criteria. Not only must you predict ultimate strength and progressive damage over time, you must identify issues related to delamination, cracking and other physical mechanisms. Knowing which layers will fail first and understanding crack characteristics and other fine levels of product analysis are crucial to successfully fulfilling your product promise.

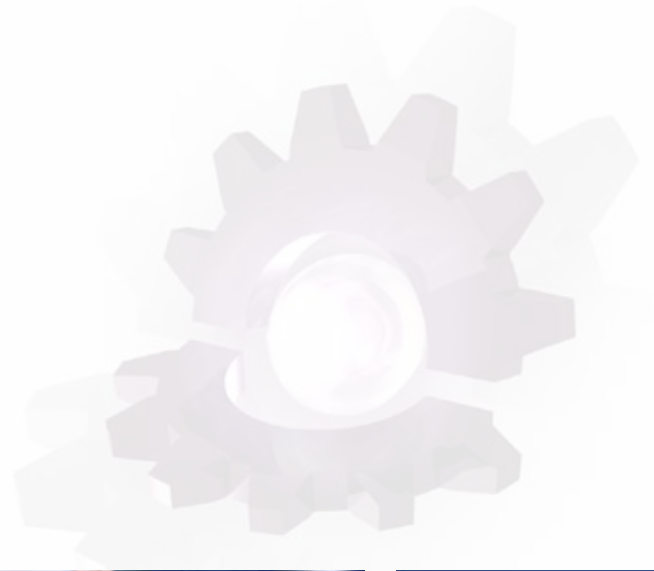
Our solution for composites — ANSYS Composite PrepPost™ — empowers you to efficiently model the most complex composite structures and, at the same time, fully understand the potential failure of product models. Working in a low-risk virtual environment, you subject your product designs to simple physical stresses and compute progressive damage, delamination and cracking.

We provide all the robust functionality you need to confidently analyze layered composite structures.



Team Alinghi used our software to build their 33rd America's Cup yacht. The work included a laminate optimization study for the hull that considered multiple load cases. Both macro- and constituent-level properties of the laminate materials were taken into account, specifying orthotropic material properties for each individual layer in the hull's sandwich-structured composite, using shell elements and the ANSYS Mechanical solver. The team evaluated ANSYS Composite PrepPost and noted its usefulness for determining characteristic material properties of laminate materials.

©Stefano Gattini/Alinghi.  
Courtesy Team Alinghi.



Carbon fiber lightweight paddle



Carbon fiber disc brake



Glider with laminate components

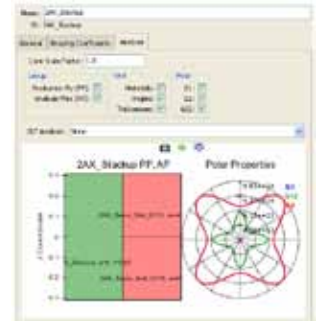


Carbon fibers



*"The intuitive implementation of ANSYS Composite PrepPost brought out a revolution in composite simulations. We are able to realize a continuous design process from simulation results to manufacturing, including design modifications within the development."*

**Hendrik Mester**  
Rotor Blade Development  
REpower Systems AG



Stack-up definition

## ANSYS delivers a range of capabilities to help you create and test composite-based product models – as well as confidently prepare for manufacturing.



Composite failure

Courtesy Kolossos via Wikimedia Commons.

An intuitive interface in ANSYS Composite PrepPost software efficiently defines materials, plies and stacking sequences; it also offers a wide choice of state-of-the-art failure criteria. ANSYS solvers provide the foundation for accurate results, while additional computations for failure criteria are performed within the ANSYS Composite PrepPost application.

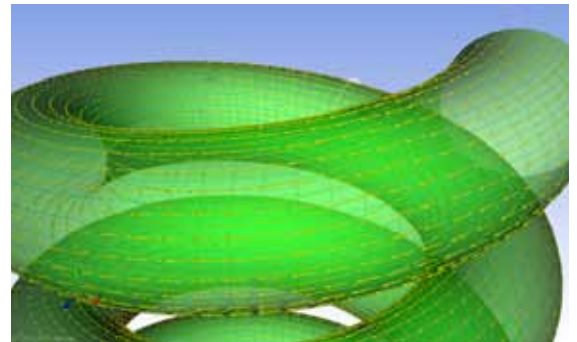
The technology's post-processing capabilities allow you to conduct in-depth investigations of ultimate product integrity and behavior. You can view global results or conduct detailed analysis at the level of individual layers.

Unique draping capabilities enable you to correctly identify the exact orientation of every layer. Two features offer support in the product manufacturing stage: flat-wrap and ply-book creation. These capabilities contribute to a high level of confidence in ultimate product integrity.

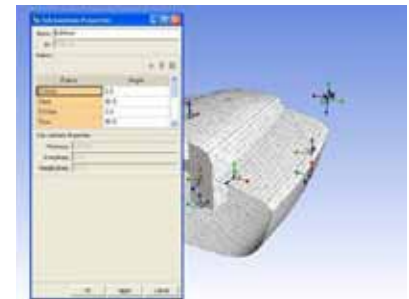
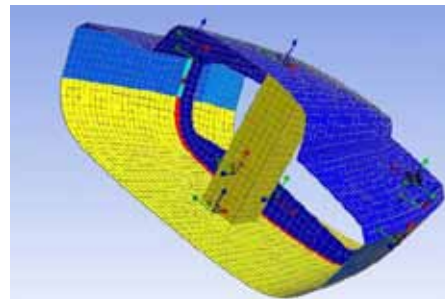
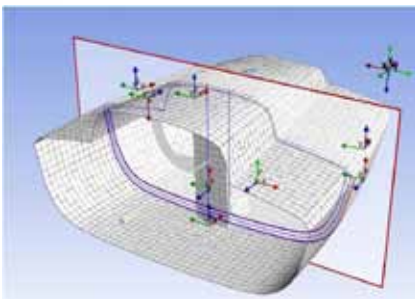
Composite engineering solutions from ANSYS work with the ANSYS Mechanical™ interface in ANSYS Workbench™ to provide a strong foundation for accurate results and advanced failure analysis. You can automate your composite structure designs through integration with the ANSYS Mechanical APDL interface to enable advanced scripting.

### Accurate, Efficient Composite Design

With ANSYS solutions, you can define composite materials, fabrics and stack-ups in a way that maximizes ultimate product integrity. Optimal materials are defined from basic engineering data, as well as advanced post-processing data based on failure criteria. You then define fabrics (one material, one thickness) or stack-ups (multiple fabrics with a specific layering and orientation). ANSYS offers symmetry capabilities that simplify and accelerate stack-up definitions.



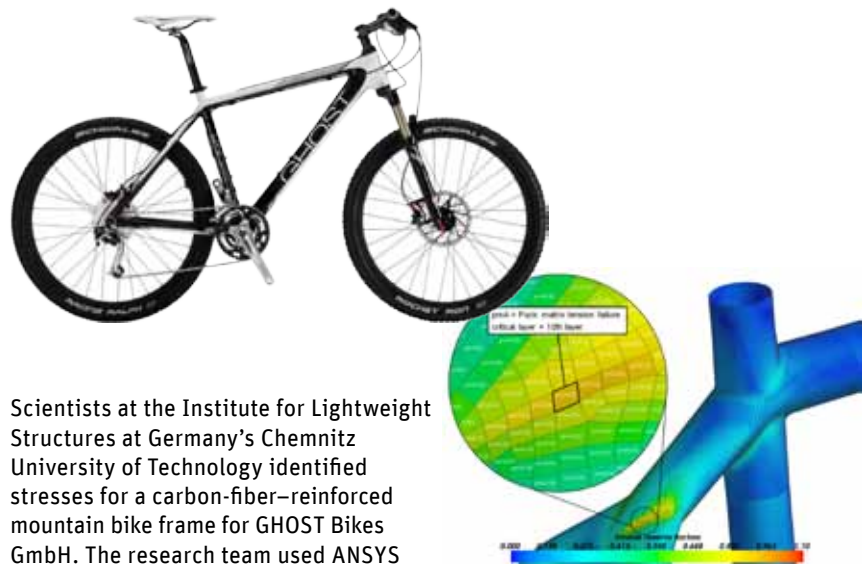
You can easily orient complex shapes with continuously changing material orientations.



ANSYS Composite PrepPost allows you to visualize thicknesses and results; it also provides material definitions for complex problems.

Our tools facilitate defining the proper base orientation and main axis of a composite via a sophisticated yet easy-to-use system of rosettes. These define materials reference directions in a generally curved structure. You simply define a discrete number of rosettes indicating local directions, then blend them to properly orient the entire structure automatically. Our tools model asymmetric laminate structures using element sets that are overlapping and oriented in multiple directions. This is a unique ANSYS capability.

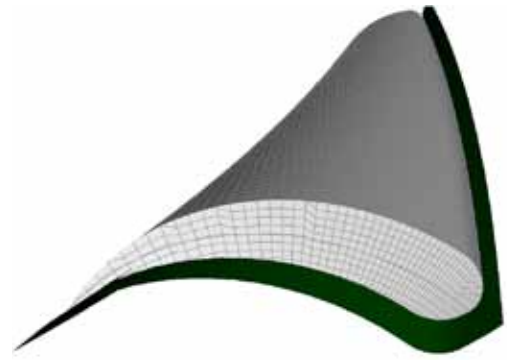
Composite PrepPost streamlines design of structures with high degrees of curvatures or rapid orientation changes. It leverages other ANSYS solutions to accurately predict both drapability and fiber angle correction necessitated by structural curvature.



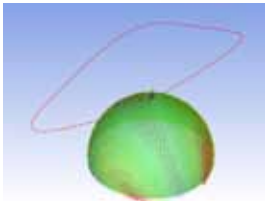
Scientists at the Institute for Lightweight Structures at Germany’s Chemnitz University of Technology identified stresses for a carbon-fiber-reinforced mountain bike frame for GHOST Bikes GmbH. The research team used ANSYS Composite PrepPost to analyze potential failure within the complex lightweight structure.

*“Compared to typical trial-and-error development methods used in the bicycle industry, we reduced the number of cost- and time-intensive physical prototypes using ANSYS.”*

**Norbert Schramm**  
Dipl. Ing. Research Assistant  
Chemnitz University of Technology



3-D composites model extrusion from a flat ply definition fitted to a given CAD geometry helps in modeling complex shapes.



Curvature correction from draping calculations on a spherical surface. The red curve represents the corresponding flat-wrap.

### Confident Prediction of Product Behavior

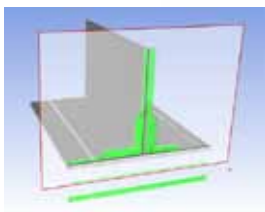
ANSYS offers a robust element library that supports layered definitions including 1-D (beams and pipes), 2-D (shells and solid shells) and 3-D modeling.

For complex 3-D shapes, Composite PrepPost provides the ability to extrude a flat definition of plies on a surface to a full 3-D model. You can perform extrusions along the normal of a surface, following the plies' thickness or, for even more complex shapes, adapt to a given geometry.

ANSYS tools assist in analyzing debonding — in which fibers are separated from the matrix — via cohesive zone models. The software allows crack characterization of composite structures using the virtual crack closure technique (VCCT). You can simulate damage initiation and propagation in fiber-reinforced composites using a nonlinear solution process to estimate the ultimate composite strength under complex stress states.

### Design for Manufacturability

Our solution helps to optimize your manufacturing processes by ensuring that designs meet the needs of real-world production facilities and equipment. ANSYS Composite PrepPost supports direct import of ply specifications into tools such as VISTAGY's FiberSIM®, which is required to deliver a detailed status of a given product's manufacturability in the early stages of product simulation.

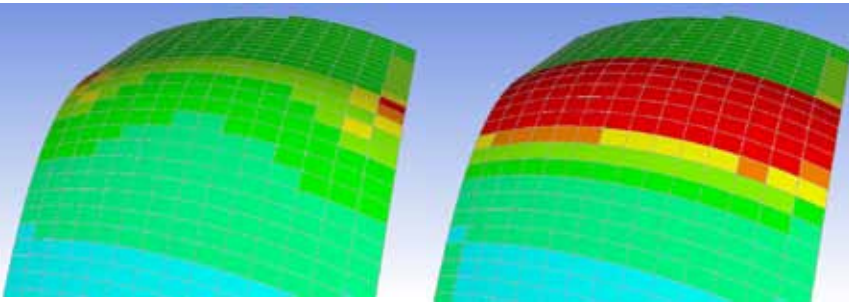


Asymmetric layer definition on T-shaped structure

Our tools allow you to model multiple layers within an individual element, assigning different material properties to each layer. Composites usually exhibit orthotropic, or even anisotropic, behavior. ANSYS layered-element formulations support hyperelastic material properties to reflect the use of rubber-like materials in composite models. Both implicit and explicit solvers are supported for composite analyses.

For failure predictions, you can analyze delamination induced by transverse shears and tension via interlaminar shear stress output. Our software addresses failure criteria including maximum strain or stress, Tsai-Wu, Tsai-Hill, Hashin, LaRC, Cuntze, and Puck 2-D and 3-D.

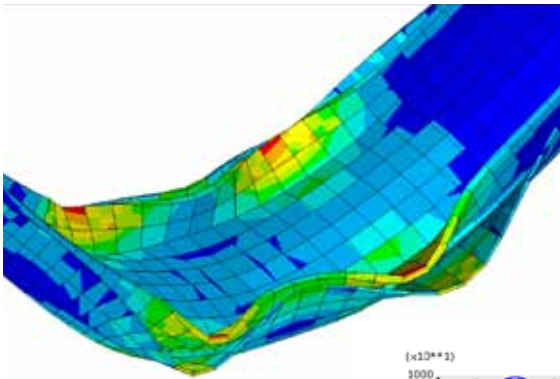
Composite PrepPost models can be easily updated based on FiberSIM's detailed inputs that check the validity of the final design. Connecting ANSYS Composite PrepPost to FiberSIM provides consistent part definition that can be released to simulation, manufacturing and certification concurrently. Capabilities for flat-wrap and creation of ply-books aid in manufacturing the final product.



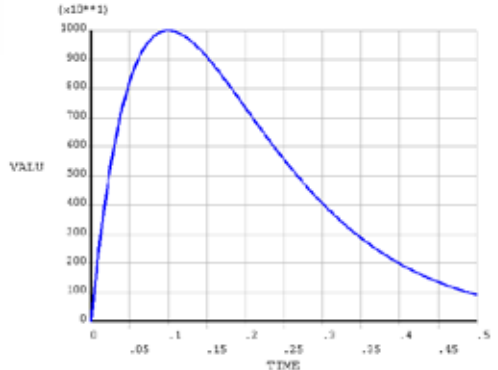
3-D stress assessment from 2-D models improves evaluation of failure. Left image shows failure based on 2-D theory; right image shows failure from through-thickness stresses.

**Simulation for the Real World**

ANSYS Composite PrepPost and other structural mechanics tools are one part of our suite that delivers state-of-the-art functionality — depth, breadth, a plethora of advanced capabilities and integrated multiphysics — providing confidence that your simulation results reflect real-world outcomes. The comprehensive range of engineering simulation solution sets provides access to virtually any field of engineering simulation that a design process requires. Organizations around the world trust ANSYS to help them realize their product promises.



Debonding of composite beam (above) and cohesive zone model (right)



---

**ANSYS, Inc.**  
www.ansys.com  
ansysinfo@ansys.com  
866.267.9724

ANSYS is dedicated exclusively to developing engineering simulation software that fosters rapid and innovative product design. Our technology enables you to predict with confidence that your product will thrive in the real world. For over 40 years, customers in the most demanding markets have trusted our solutions to help ensure the integrity of their products and drive business success through innovation.

ANSYS and any and all ANSYS, Inc. brand, product, service and feature names, logos and slogans are registered trademarks or trademarks of ANSYS, Inc. or its subsidiaries in the United States or other countries. All other brand, product, service and feature names or trademarks are the property of their respective owners.