

NX Laminate Composites: Simulate composite structures

NX CAE

Benefits

- Reduce laminate model creation time by choosing between zone-based modeling, ply-based modeling or a mixture of both approaches
- Cut model rework time through geometry associativity, which keeps your model up-to-date with the latest design
- Quickly assess design changes by applying laminates and global plies directly to elements without using geometry
- Ensure that laminate properties, ply materials and layups are always up-to-date after changes to material properties
- Interact with CAD-based composites definitions by importing ply orientations from FiberSIM
- Improve finite element modeling accuracy by accounting for distorted fiber orientations
- Quickly determine viability using advanced post-processing tools

Summary

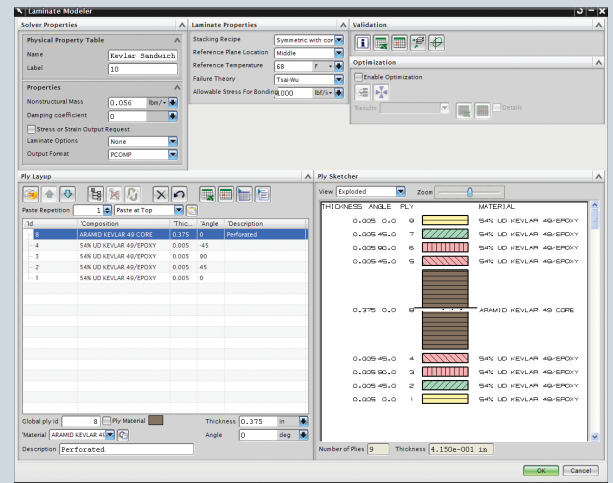
NX™ Laminate Composites software is a modular NX simulation toolset for laminate composite structures. Easy-to-use ply and laminate definition tools enable you to quickly create finite element models representing your laminate composite design. NX Laminate Composites helps you create, optimize and validate composite structures using NX Nastran®, MSC. NASTRAN, Ansys, Abaqus, or LS-Dyna as your solver. Post-processing tools and advanced reporting tools allow you to efficiently identify problem areas from your simulation results.

Zone-based modeling

NX Laminate Composites enables you to attach your laminates directly to 2D or 3D mesh collectors. An interactive graphical modeler helps you to create and stack laminated composite plies efficiently. You can use standard pre-defined stacking sequences and/or ply groups to minimize the effort required to create and modify complex, multi-ply laminates. You also can import your laminate from Microsoft Excel.

Ply-based modeling

You can use NX Laminate Composites to create global plies, assign them to polygon faces and/or 2D elements and define ply orientations by projection of the material orientation or by using one of the draping algorithms. You can stack the plies in the layup modeler and optionally define ply angular offsets. NX automatically computes element zones for solver export. You can assign different layup offsets on different faces and view the fiber orientations on the 2D meshes. Additionally, you can extend plies



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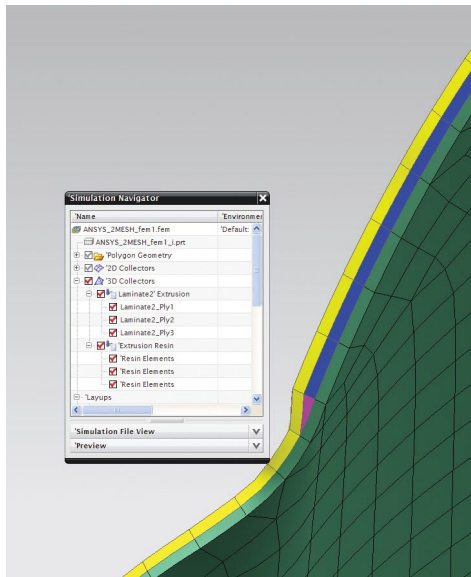
from one layup to another to simulate the secondary bonding process between pre-cured composite parts.

Bi-directional FiberSIM interface

Import and export FiberSIM CEE ply data, including the FiberSIM material properties, to and from a global layup.

3D layup inflation

NX Laminate Composites enables analysts using the NX Nastran, Abaqus and Ansys solvers to create a 3D representation of their global layups by extruding normally to a 2D mesh or by filling the volume between 2D dependent meshes. Each ply or ply group then becomes a distinct 3D mesh, the thickness of which is taken from the layup definition; ply drop-offs are modeled as wedge, brick or pyramid elements. Thickness tolerances allow you to taper core or filler plies.



Draping

NX Laminate Composites draping algorithms predict the fiber orientations and shear of unidirectional and woven plies as they drape around doubly-curved or undevelopable surfaces. NX enables you to specify a draping start point and an initial

draping direction, or to pick a seed curve. You can then coarsen or refine the drape mesh size and view the ply flat pattern.

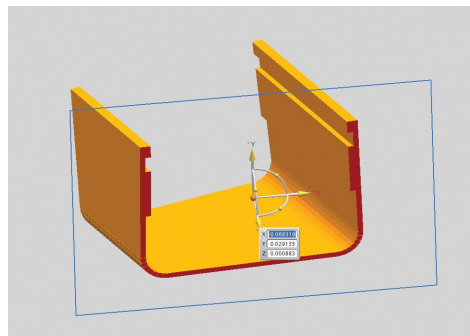
Ply materials

You can combine fiber and matrix properties to create ply materials, which can be used in the laminate stack just like standard NX materials. Micromechanics theories allow you to create ply materials with the following types of fibers:

- Unidirectional
- Woven (you can specify the angle between the warp and weft fibers)
- Particulate
- Randomly oriented short fiber

Laminate validation

To visually validate your laminate, you can view the thickness and the offsets (both nodal and reference plane location) of your laminate physical properties and your layups. Contour plots of laminate thickness are also possible, helping you visually understand your model.



You also can view the element zones and assigned laminate property, as well as create element groups from those zones to more easily manage your FE model. Laminate stiffness matrices (A, B, D and S) can be displayed in both Microsoft Excel and text formats. Similarly, equivalent engineering constants can also be displayed, enabling you to assess the characteristics of your laminate prior to solution.

You can apply loads and temperatures to your laminate and review the ply stresses, strains, failure indices and margins of safety. NX Laminate Composites supports the following failure theories:

- Maximum stress
- Maximum strain
- Hill
- Hoffman
- Tsai-Wu
- Puck
- LaRC02

Through-thickness ply stress and strain charts, as well as ply failure envelopes, enable you to assess the viability of your laminate.

Optimization

NX laminate optimization allows you to improve the fundamental properties of your laminate. You can optimize a laminate physical property to meet stiffness, stability, strength or mass objectives. A genetic optimizer handles continuous variables such as an orientation angle and ply thickness, as well as discrete variables such as the existence of a ply, ply material, thickness and orientation. The software provides five laminate definitions that come the closest to meeting the objectives. You can select one of the five to replace the original laminate.

In addition, your continuous thickness and orientation design variables can be exported as modeling objects and used to define NX Nastran design optimization solutions.

Solver support

You can assign laminates to shell or solid elements, which then can be used for the following supported solvers.

Nastran

- PCOMP/PCOMPG – MEM/BEND/SMEAR/SMCORE
- PCOMPS
- PSHELL
- 2D: CQUAD4/R/8, CTRIA3/R/6
- 3D: CHEXA, CPENTA

Ansys

- 2D: SHELL181, SHELL281, SHELL99, SHELL91, SOLSH190
- 3D: SOLID186, SOLID191, SOLSH190

Abaqus

- 2D: S8R, S8R5, S4, S4R, S4R5, STRI65, S3, S3R, STRI3
- 3D: SC6R, SC8R, C3D8, C3D20

LS-Dyna

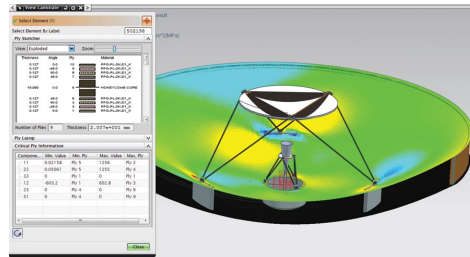
- 2D: *ELEMENT_SHELL
- 3D: *ELEMENT_TSHELL

Postprocessing

NX postprocessing allows you to view shell stress resultants, ply stresses, ply strains, ply failure indices (ply and bond) and ply strength ratios (ply and bond).

NX Laminate Composites provides enveloping, filtering and sorting tools that enable you to quickly identify the critical element and ply over many solutions, including imported results. NX reads solver shell stress resultants and/or ply stresses,

and computes ply strains, stresses, ply failure indices and margins of safety. It then graphically displays the critical ply ID for each element.



NX Laminate Composites also computes core ply transverse shear failure indices, strength ratios and margins of safety using allowable shear stresses in the 23 and 13 directions.

NX graphical post reporting uses the laminate properties in your active FEM, so that you can switch failure theories and even modify your laminates after the

solution to perform what-if analyses. Reporting will update draping and zones if required, prior to accessing results.

To speed reporting for multiple or large solution files, you can use Quick Post reporting, which does not query the active FE model.

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