SIEMENS

NX Laminate Composites

Modeling and simulating composite structures

Benefits
- Reduce laminate model creation time by choosing between zone-based modeling, ply-based modeling or a mixture of both approaches
- Leverage NX CAE's open solver architecture to perform state-of-the-art dynamic, nonlinear, progressive failure and delamination simulations
- Keep your model up-to-date with the latest design through geometry associativity
- Interact with CAD-based composites definitions from Fibersim, CATIA and others
- Ensure that laminate properties, ply materials and layups are always up-to-date after changes to material properties

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, LMS Samcef, 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.
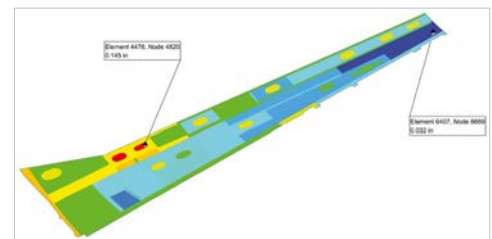
Fibersim interaction
Use the bi-directional Fibersim ply exchange to communicate with composites designers. Ply import can seamlessly operate via the NX .prt file. You can also

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Benefits *continued*
- Quickly assess design changes by applying laminates directly to elements without using geometry

- Improve finite element modeling accuracy by accounting for distorted fiber orientations

- Quickly determine viability using advanced post-processing tools

exchange zone and laminate definitions via the zone interfaces.

Interface with other tools
Import ply definitions from third-party tools such as CATIA, Patran Laminate Modeler and Simulayt Laminate Tools.

3D layup inflation
NX Laminate Composites enables analysts 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.

Dynamic simulation
Use NX Nastran, NX Response Simulation and the NX Laminate Composites dynamics metasolution to generate ply results for dynamic events. The dynamics metasolution uses advanced algorithms and a parallelized solver to efficiently compute peak random ply stresses, strains, failure indices, strength ratios and margins of safety.

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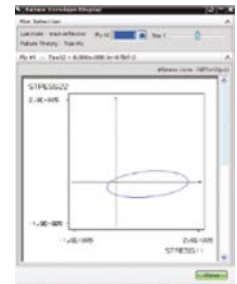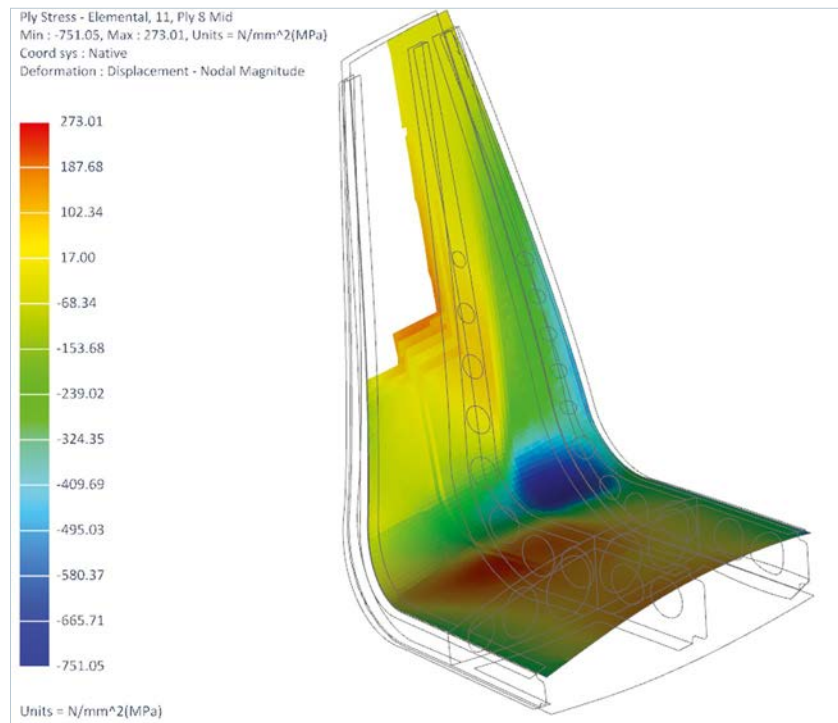
Ply materials
You can combine fiber and matrix properties to create ply materials, which can be used in the laminate stack just like standard NX materials. Micromechanics theories allow you to create ply materials with the following types of fibers:

- Unidirectional

- Woven (you can specify the angle between the warp and weft fibers)

- Particulate

- Randomly oriented short fiber

A core ply material allows you to define thickness-dependent shear stress limits.

Laminate validation
To visually validate your laminate, you can view the thickness and the offsets (both

Ply Stress - Elemental, 11, Ply 8 Mid
Min : -751.05, Max : 273.01, Units = N/mm^2(MPa)
Coord sys : Native
Deformation : Displacement - Nodal Magnitude

273.01
187.68
102.34
17.00
-68.34
-153.68
-239.02
-324.35
-409.69
-495.03
-580.37
-665.71
-751.05

Units = N/mm^2(MPa)

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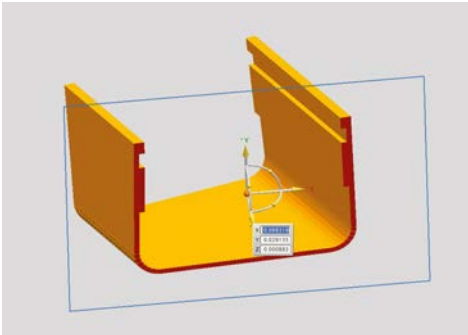
You also can view the element zones and assigned laminate property, as well as create element groups from those zones to more easily manage your FE model. Laminate stiffness matrices (A, B, D and S) can be displayed in both Microsoft Excel and text formats. Similarly, equivalent engineering constants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

Failure theories
NX Laminate Composites supports the following failure theories:

- Maximum stress
- Maximum strain
- Hill
- Hoffman
- Tsai-Wu
- Puck
- LaRC02
- Von Mises
- Core shear
- User-defined

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.
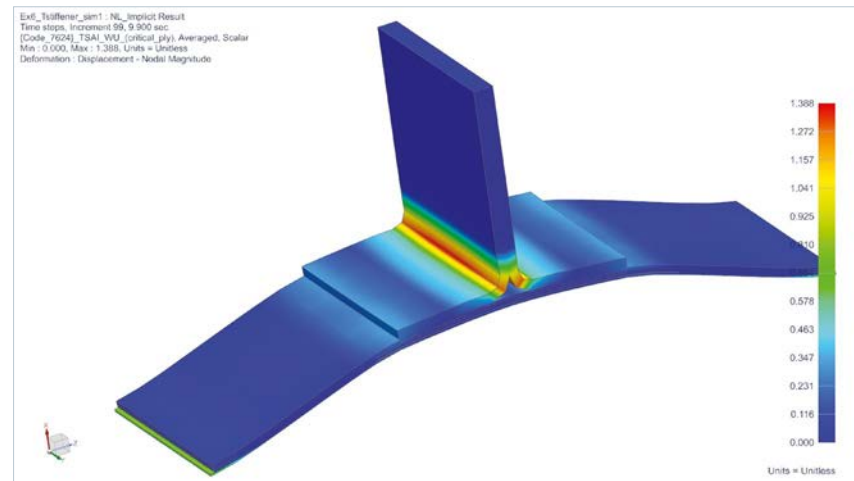
In addition, your continuous thickness and orientation design variables can be exported as modeling objects and used to define NX Nastran Solution 200 design optimization studies.

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

Nastran
- PCOMP/PCOMPG/PSHELL
- PCOMPS/PSOLID
- 2D: CQUAD4/R/8, CTRIA3/R/6
- 3D: CHEXA, CPENTA

SAMCEF

- 2D : Mindlin Shell (T28, T29), Heterosis Shell (T155,T156), Membrane (T57, T58), Membrane Shell (T53)

- 3D : Solid (T8, T46), Solid Shell (T153, T154), Cohesive Element (T145,T147) , Non local element (T182, T183)

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, C3D8H, C3D8R, C3D8RH, C3D8I, C3D8IH, C3D20, C3D20H, C3D20R and C3D20RH

LS-Dyna

- 2D: ELEMENT_SHELL, PART_COMPOSITE

- 3D: ELEMENT_TSHELL, PART_ COMPOSITE_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.
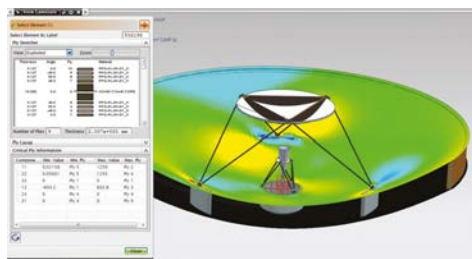
NX Laminate Composites also computes core ply transverse shear failure indices, strength ratios and margins of safety using allowable shear stresses in the 23 and 13 directions.

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.