FIREHOLE COMPOSITES
ANALYSIS SOFTWARE & SERVICES

Enable Better Engineering Decisions with Helius:MCT

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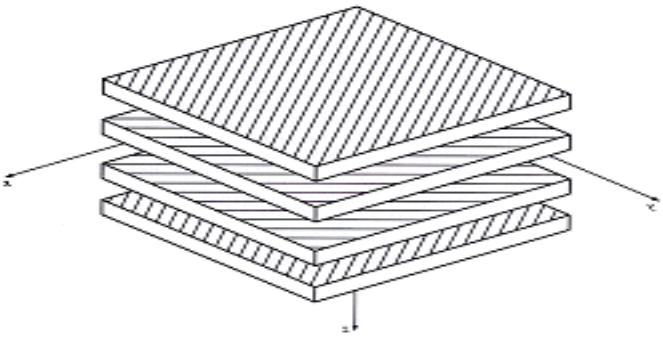
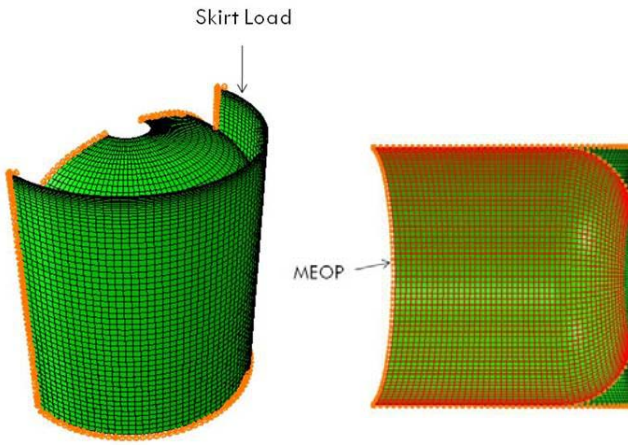
A Look at Optimizing Laminate Thickness



HELIUS:MCT
ADVANCED COMPOSITES SIMULATION | FIREHOLE COMPOSITES

Helius:MCT is an add-on for Abaqus™ and ANSYS™ that is specifically designed to enhance the failure analysis of composite materials.

The progressive failure capability in Helius:MCT allows for the prediction of initiation ***and*** propagation of matrix/fiber failure, providing a useful tool for simulating the ultimate failure loads and modes in composite parts.



Option 1: Traditional Composite Failure Analysis

First, a ***traditional first ply failure*** analysis is used on the laminate. In multi-axial laminates, the first ply failure is typically a matrix failure – leading to a very conservative failure prediction.

According to these results, 32 plies are needed to meet the ultimate strength requirement.

Example Scenario: Filament Wound Carbon Fiber Tank Design

The stress analysis team has issued load requirements including an ultimate strength requirement (including safety factor) of Skirt Load (F_x)= 850 kN, MEOP (F_y) = 470 kN.

Manufacturing requirements for the part require it to be an x-ply, carbon-epoxy, quasi-isotropic $[0°/\pm45°/90°]_s$, symmetric laminate.

The goal is to use analysis to determine how many plies (x) are needed to meet the ultimate strength requirement.

Traditional First Ply Failure Analysis		
Number of Plies	F_X (kN)	F_Y (kN)
8	284.7	158.0
16	564.3	313.2
24	844.0	468.5
32	**1125.0**	**624.4**

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Option 2: Helius:MCT Multiscale Analysis

A Helius:MCT analysis predicts both matrix and fiber failure and so the analyst can use ***first ply fiber failure*** as the criteria because it correlates to ultimate failure of the laminate more accurately.

These results show that only 16 plies are needed to meet the ultimate strength requirement.

- The same FEA model can be used.
- Conversion only takes minutes.
- Only the material definition changes.

Helius:MCT Multiscale First Ply Failure Analysis		
Number of Plies	F_X (kN)	F_Y (kN)
8	431	239
16	862	478

- Run time is typically on 1 to 2% longer.
- Material library files can be used many times over.
- No additional input parameters are required.

Finally the analyst can consider using a Helius:MCT ***progressive failure analysis*** allowing for a simulation of not only failure initiation but ultimate structural failure.

This shows that only 8 plies are needed to meet the requirement.

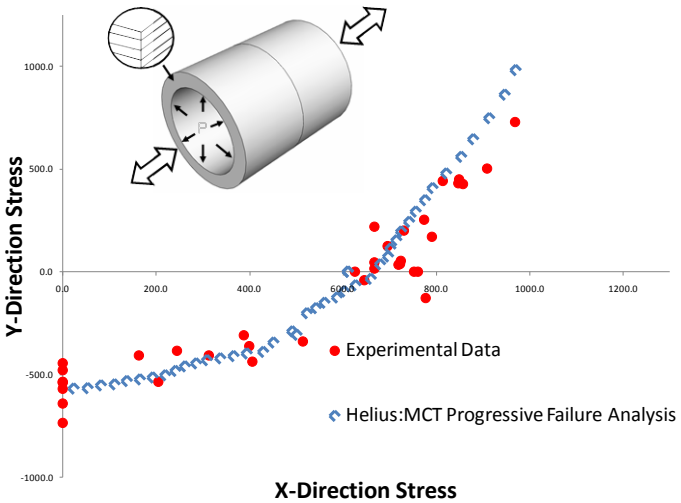
- The same FEA model can be used.
- Failure initiation and progression are provided as visual output so actual part failure can been seen in a simulation environment
- A nonlinear analysis is required due the reduction of structural stiffness matrix and fiber failure cause in the composite part

Helius:MCT Multiscale Progressive Failure Analysis		
Number of Plies	F_X (kN)	F_Y (kN)
8	903	526

Helius:MCT reduced the necessary number of plies by 75%!

The number of plies relates directly to the **weight** of the component, the **manufacturing complexity** and **time required**, and the **overall material costs**.

Experimental Comparison



Experimentally, this scenario was tested using cylinders to create mulit-axial load states using an 8-ply laminate.

Four our case, the stress ratio was $\sigma_X:\sigma_Y$ = 1.80:1.0. The cylinders were loaded at a constant stress ratio until ultimate failure and the accuracy of using the Helius:MCT progressive failure analysis was proven to be a valuable design asset.

Experimental Results		
Specimen	F_X (kN)	F_Y (kN)
1	998.8	554.4
2	943.1	471.6
3	931.8	475.8
4	933.9	495.0
Helius:MCT	**903.1**	**536.9**

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