COMPANY

NASA's Goddard Space Flight Center

LOCATION

Greenbelt, Maryland, United States

SOFTWARE

Autodesk® Helius PFA
Autodesk® Helius Composite

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>
> — **Terry Fan**
> NASA's Goddard Space Flight Center

Composite virtual reality

Autodesk solutions help NASA CoEx team explore new composite materials virtually while saving time and cost

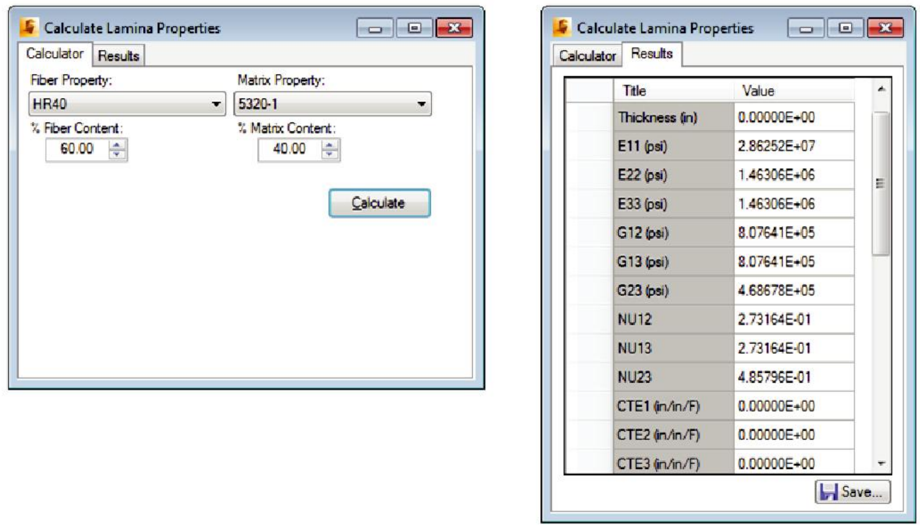

Image courtesy of NASA's Goddard Space Flight Center

Project summary

Composites for Exploration (CoEx), part of the National Aeronautics and Space Administration's (NASA) Advanced Exploration Systems initiative, develops out-of-autoclave composite materials and structures for the next generation of the agency's heavy-lift launch vehicles. The project is intended to enable significant savings in weight and lifecycle cost, while also developing technology NASA engineers can use to produce the largest composite aerospace structures ever made.

The challenge

The CoEx joint team at NASA's Goddard Space Flight Center in Greenbelt, Maryland, is responsible for developing payload fairing composite joints and performing repair analyses. One challenge the CoEx team has encountered in their work is estimating the mechanical properties of the out-of-autoclave composite materials for structural analysis. A common issue that composite engineers face is finding material property data necessary for analysis and simulation. Often, published material data is missing required properties, or resultant lamina data is needed to explore different combinations of composite constituents.

The CoEx team can quickly add new fiber and resins to their material database with Autodesk Simulation software

The CoEx composites repair team had selected a HR40/5320-1 unidirectional prepreg tape with a [0/45/90/-45]s layup for out-of-autoclave repair. The properties for this specific material were not available for analyses. The CoEx team found two existing data sheets for reference; however, neither document had the right constituent materials combination. Data sheet A had the desired matrix: CYCOM® 5320-1 resin, with a T40/800B fiber. Data sheet B had the desired fiber: PYROFIL™ HR40 12K (HR40), with a Rayon #350 resin.

Unable to find existing material data, the team could either test—if time and budget allowed— or estimate properties based on availability of existing material data deemed “similar.” Both choices were unfavorable, so the team pursued a third option: find an analysis solution.

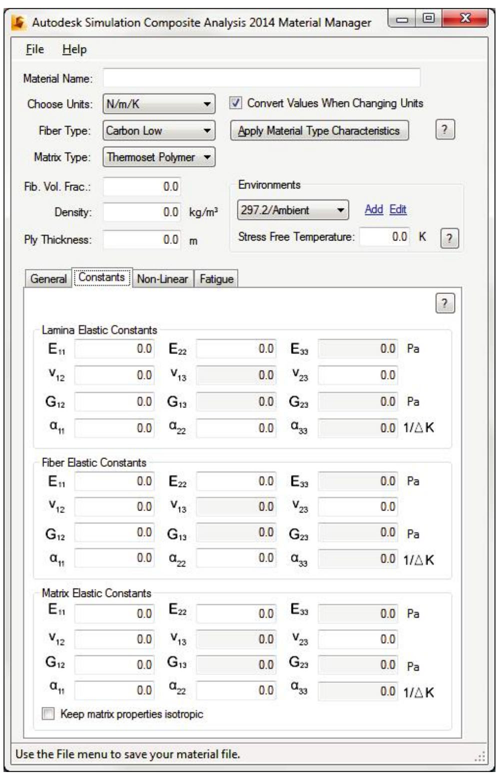

Image courtesy of NASA’s Goddard Space Flight Center

The solution

CoEx engineers looked for a practical software solution that could give them an accurate, repeatable way to take the information they had and then obtain the data they needed. They decided to take a two-step approach using Autodesk® Helius PFA and Autodesk® Helius Composite. Through this approach, the CoEx engineers would use a micromechanics-based method to first extract the constituent properties of materials A and B and then apply them to determine the resultant properties of their desired layup.

Using the composite analysis tools in Autodesk Helius PFA software, the CoEx team was able to take a constituent-based approach to finite element analysis of composite materials.

One feature of Autodesk Helius PFA is the Composite Material Manager, an internal, unit cell, micromechanical finite element model for deriving the constituent properties of a laminate. User-selected initial fiber and resin properties (in this case, default carbon fiber and epoxy properties) are adjusted iteratively to minimize the error between the measured composite properties and the predicted properties of the micromechanical finite element model.

With the Composite Material Manager tool, CoEx engineers were able to back out the properties of their desired constituents from data sheets A and B. The team then used Autodesk Helius Composite software to apply the extracted constituent properties and calculate the resultant properties of their desired laminate. They also were able to add the new fiber and resins quickly and easily to their existing material database.

The results

Autodesk Helius PFA software as the first step helped the CoEx team obtain mechanical properties for the fiber and resin constituents of laminas A and B. They used Autodesk Helius Composite software to reconstruct laminas A and B to assess the accuracy of the process. The resulting lamina properties predicted by Autodesk Helius Composite were, on average, within 1.7 percent of the measured values on data sheets A and B.

This gave the team confidence to use the derived constituent properties to estimate properties for the desired HR40/5320-1 layup. The calculated properties were deemed reasonable, and then used for analysis until test data became available. Analysis with Autodesk Helius PFA also gave the CoEx engineers the flexibility to pursue optimal materials for their design objectives.

“This example shows that software and underlying technology exist for us to virtually create and understand composite materials,” says Terry Fan with NASA’s Goddard Space Flight Center. “The tools in Autodesk Helius PFA and Autodesk Helius Composite allowed us to ‘think outside the box.’ We were able to leverage the experimental data we had to predict performance of the composite material we needed. This equates to reduced testing time and testing dollars. We look forward to applying the tools in Autodesk Helius PFA and Autodesk Helius Composite software against other composites challenges.”

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Learn more

Learn more about Autodesk Helius software at **www.autodesk.com/products/simulation /overview.**

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