Case Study: **e-Xstream engineering**

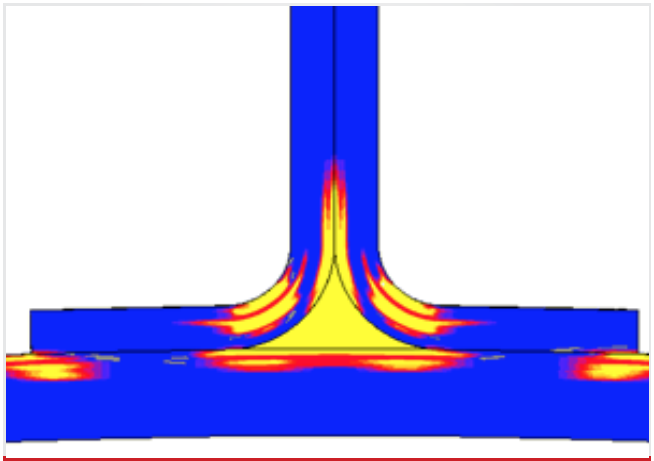
Use of Digimat to Simulate Progressive Failure in a T-Stiffener Accounting Voids Due to Manufacturing Defects

Challenge

Laminate T-stiffeners are widely used in the aerospace industry to transfer the 3D complex loads between the stiffeners and the skins. However, the way they are manufactured can affect the inherent properties.

In this case, we have considered that the stiffener and the skin were assembled using an RTM process but because of the poor infiltration of the resin due to the fiber orientation changings, some dry spots appear in the noodle. These dry spots or voids affect the mechanical properties of the noodle and this knock-down of properties must be taken into account during the design process.

In addition, the design of such component requires taking into account the progressive damage that can appear in the composite during the pull-off test.



Understand the effect of defect on the damage propagation with Digimat

"Digimat enables us to simulate and understand the failure sequence of an aircraft component using an advanced progressive failure method accounting the effects of defects. Thus, offering new solutions to develop composite parts."

Wang Xuan, Application Engineer, e-Xstream engineering

Solution

Digimat, effective modeling solution

In this application case, the properties of two materials must be calibrated. If the properties of the skin and stiffener can be determined directly from datasheet, getting the stiffness and strength allowables of the composites accounting the presence of voids is more challenging.

A complete methodology based on micromechanics and finite element analysis of the material itself can then be used. In this case, Digimat-MF is used to calibrate the progressive damage behavior of the healthy material, the material used for the skin and the stiffener.

Digimat-MF and FE are used simultaneously to compute the stiffness and the strength of the material with voids. Once the material properties are defined and applied on the structure, the FE analysis of the part is performed using a coupling between MSC Marc and Digimat-CAE. Digimat runs in parallel with the FE solver to calculate the true material behavior based on the material microstructure and delivers the calibrated mechanical properties back to the solver including any progressive failure of the materials.

Results/Benefits

Capture True Materials Behavior

- Study sensitivity of material properties to voids: Evaluate the effects of defects such as voids compared to the same material
- Validate the design: Evaluate potential failure modes of the component and assess the strength of the part accounting the progressive failure in the material.

With Digimat, effective modeling solution enables to understand the sequence of failure of the structure and the resultant load level.

Key Highlights:

Product: Digimat-VA

CAE Technology:
MSC's Marc

Industry:
Aerospace

Application:
Virtual Properties Prediction

Performances:
Stiffness, failure with progressive damage

The results allowed to capture the progressive loss of stiffness of the structure and the resulting load.

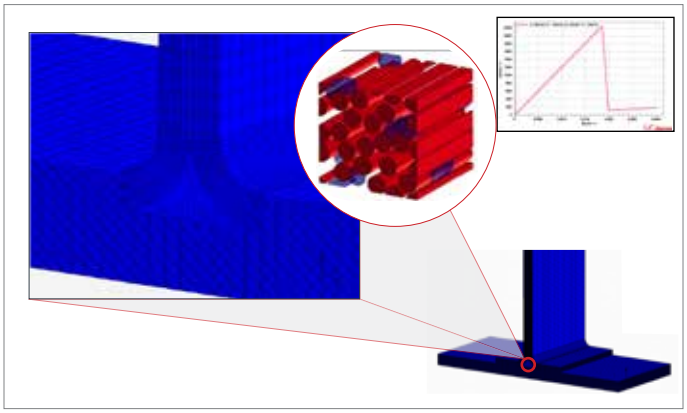


Figure 1: The stiffness and progressive failure behavior are calibrated from Datasheet using Digimat-MF

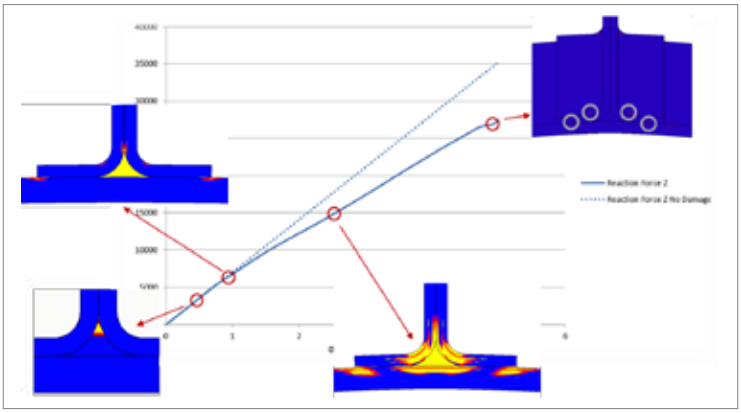


Figure 2: Force displacement curve with progressive damage

For more information on Digimat and for additional Case Studies, please visit **www.e-Xstream.com.**

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