Case Study: e-Xstream engineering

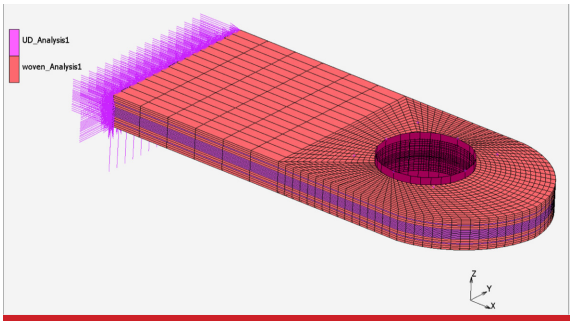
Failure Prediction of hybrid UD/Woven Laminated Pin-Loaded Joints

Digimat to predict failure loads and modes using progressive failure of SFRP for different design of a mechanical joint

Summary

Mechanical joints with fasteners are widely used for aircraft primary structures to assemble composite parts. In the case of a pin-loaded joint, stress concentration takes place on each side of the fastener leading to the apparition of local failure before the final failure of the assembly. Depends on the geometry of the joint, different failure modes may appear.

Although tests are frequently conducted to support the design of such components, the benefits of a simulation tool such as Digimat is obvious if the material modeling used is able to reproduce properly the damage behavior of the composites (unidirectional or woven reinforcement) in order to predict accurately not only the failure load but also the failure mode.



Parameterized model with UD and woven reinforcement

"Using the progressive failure capability for CFRP of Digimat, it is now possible to analysis and support the design of any type of assembly of composite parts."

– Anthony Cheruet, Business Development Engineer, e-Xstream engineering

Challenge

- The composite part under study is a hybrid laminated structure made of carbon-fiber unidirectional plies and a carbon-fiber woven reinforced ply. Hence, for each material, a progressive damage material is calibrated using the standard feature of Digimat MF based on stiffness and strength values.
- Pin-join simulation can lead to various failure mode depends on the geometry of the components.

Solution

- Definition of the Progressive Failure Material model for both the UD and woven reinforced composite
- Definition of a parameterized MSC MARC finite element model to seamlessly perform a coupled analysis with Digimat.

Results Validation / Correlation to Test Data

The input data and results of this analysis are available in [1]. Authors reports the failure modes and loads for 3 configurations.

- Correct prediction of the Failure Mode for each geometry
- Correct prediction of the Failure load for each geometry

Results / Benefits

- Good reproduction of the failure mode for the tested configuration
- Good prediction of the failure load level
- Possibility to investigate any type of geometry with confidence at no cost.

Key Highlights:

Digimat:
Digimat-MF, Digimat-CAE

Industry:
Aerospace

CAE Technology:
MSC Marc

Material:
UD / woven composites

Industry:
Automotive

Application:
Failure Prediction using progressive damage modeling

Performances:
Structure

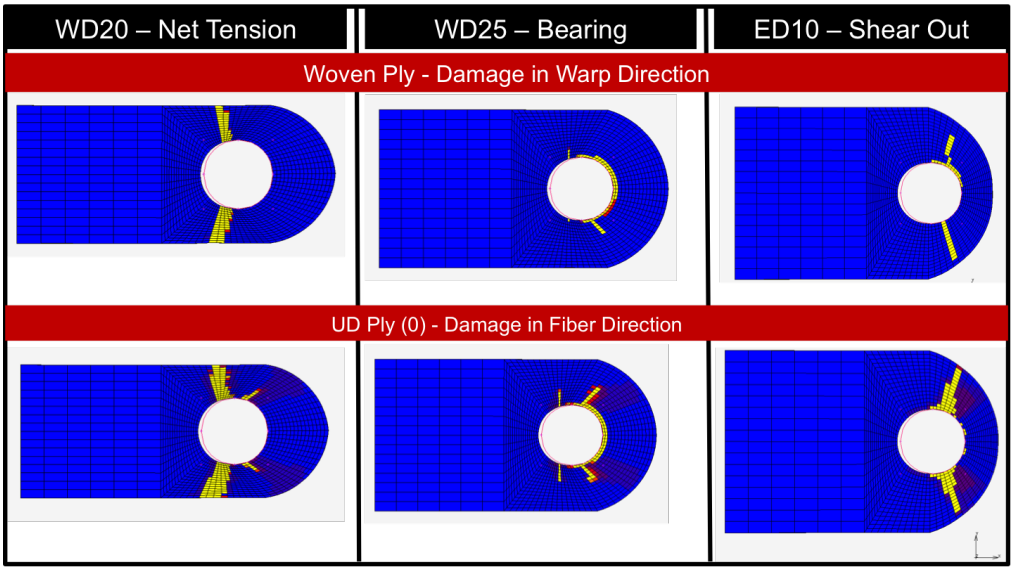


Figure 1: Prediction of the Failure Mode using the Damage indicator in the reinforcement direction

[1] Failure of Unidirectional-woven Composites Laminated Pin-Loaded Joints. HS. Ahn, JH Kweon, JH Choi. Journal of reinforced plastic and composites, vol. 24, No. 7/2005

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

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