



Case Study: Validating Digimat-VA from the coupon tests

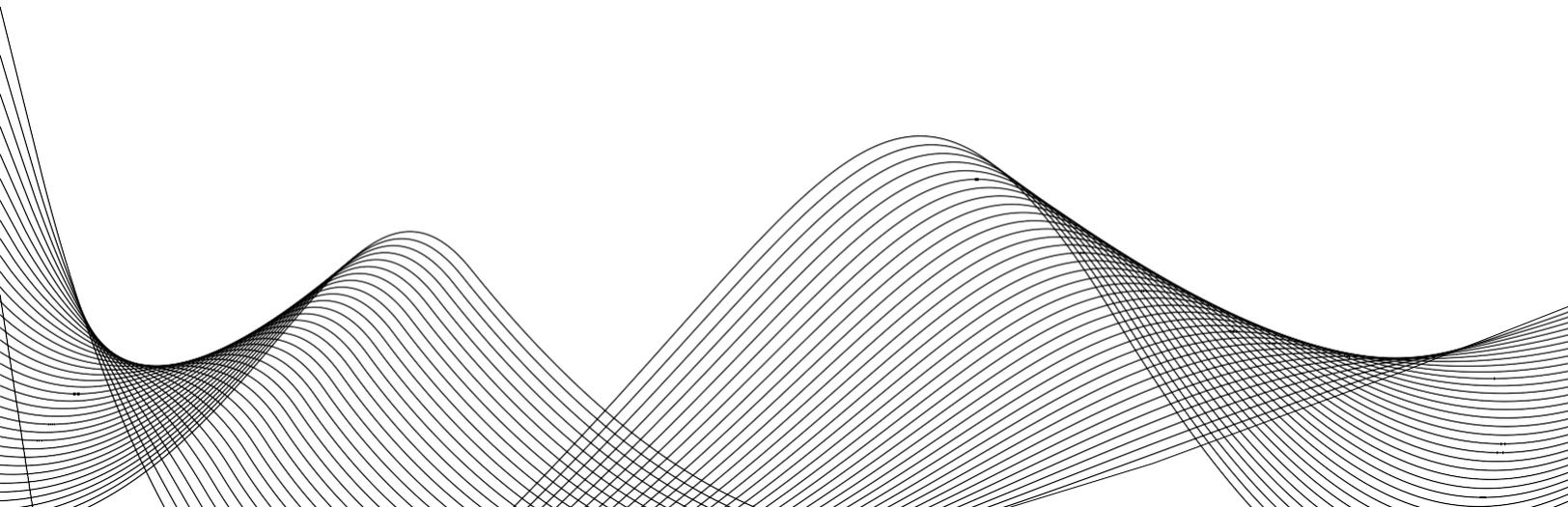
Challenge

Material characterization of continuous Carbon Fiber Reinforced Plastics (CFRP) is time consuming and expensive. The tests usually demands a large test matrix. Some of the typical tests that are carried out during material characterization are Open Hole Tension (OHT), Open Hole compression (OHC), Unnotched Tension (UNT), Unnotched Compression(UNC) and bearing test etc. These tests are repeated for different layup sequences and for batches to account for process and material variability.

Predicting the accurate stiffness, strength, failure and damage of the coupons is crucial during the characterization of the coupons. Anticipating the laminate properties for different coupons as an input of the lamina properties can reduce the experimental tests considerably. In this study, the test results of the coupons are validated with the Digimat-VA results for different layup sequences. The considered test geometries and layup sequences are shown in Figure 1.

Cured ply thickness	0.17mm
OHT & UNT specimen dimensions	250 mm (L) x 36mm (W)
OHC & UNC specimen dimensions	306 mm (L) x 36mm (W)
Lay up sequence (OHT,OHC)	[+45/0/-45/90/+45/0/-45/90] _s
Lay up sequence (OHT_L1)	[+45/90/-45/0/+45/0/-45/0/90/0/-45/0/+45/0/-45/90/+45]
Lay up sequence (OHT_L2)	[+45/0/-45/90] _{2s}
Lay up sequence (OHT_L3)	[+45/0/-45/0/+45/0/-45/0/90] _s

Figure 1: Test coupons and layup sequences considered for the experiments.



11.35% deviation.

Digmat Solution

The Digmat-VA (Virtual Allowable) is a promising tool that simulates physical coupon testing of any desired layup or sensitivity to any model parameter. It uses multiscale mean-field homogenization techniques to describe the ply response based on constituent behavior by considering the anisotropy, stiffness, strength, and fiber microstructure of composites. All the properties used for Digmat input are mean values hence output is compared with mean values of the test.

The deviation compared to test results is within 6% using Digmat-VA (As shown in Figure 2) except for the second test showing

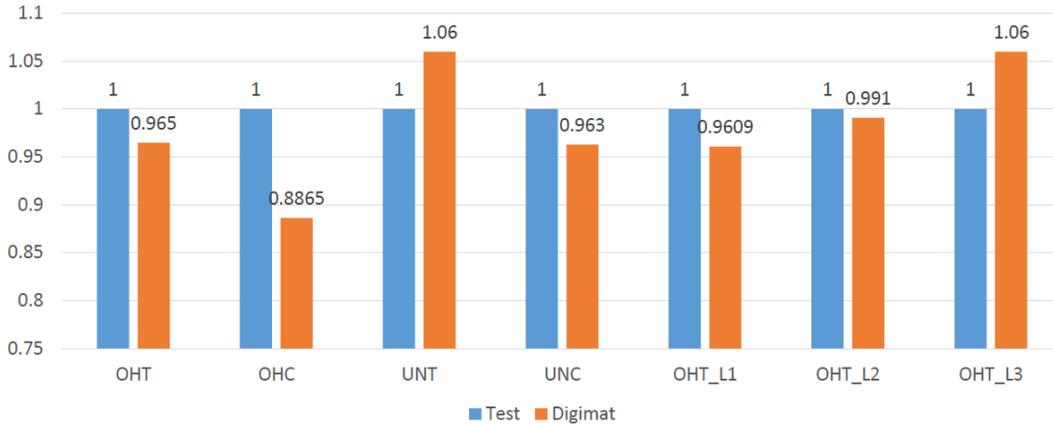
Key Highlights:

Product: Digmat-VA

Industry: Aerospace

Challenge: Characterization of CFRP using virtual allowable

Solution: Multiscale non-linear VA simulation



Specimen Name	Specimen Dimensions (in mm)	Hole Diameter (in mm)
OHT_L1	175(L)x 36 (W)	6
OHT_L2	250(L)x 48 (W)	8
OHT_L3	250(L)x 48 (W)	8

Figure 2: Mean normalized values of the test compared with the Digmat-VA normalized values

Benefit

The results show a close correlation of calculated allowable with physical tests. Advanced multiscale FE-based tool, Digmat-VA promises to reduce the experimental tests significantly for future allowable campaigns for National Aerospace Labs – Advanced Composites Division thereby ensuring considerable time and cost savings. Digmat-VA can help to build a library of virtual allowable to compare the coupon strength for each layup and each material system without requiring to execute a test campaign beforehand. Such allowable can be used in design method for early design verification. Physical tests would be required for only those configurations that have been integrated in the design.

For more information on MSC Digmat and for additional Case Studies, please visit: www.mscsoftware.com/product/digmat