Case Study: Volvo Car Corporation

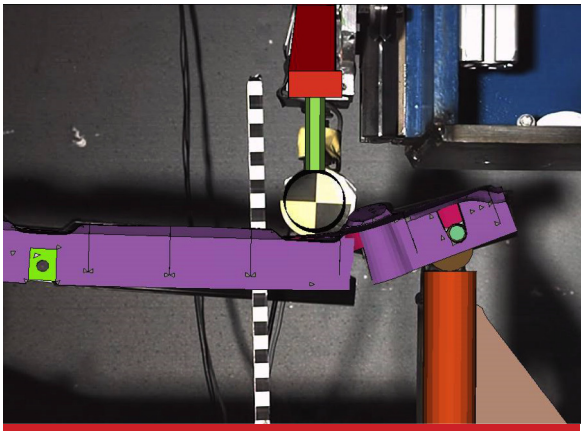
Digimat Material Model for Short Fiber Reinforced Plastics at Volvo Car Corporation

Quasi-static and dynamic failure prediction on a front end carrier

Challenge

With the collaboration of the Digimat distributor Dynamore Nordic, Volvo Car Corporation has studied the potential of Digimat local anisotropic material model for modeling reinforced plastics. The interests in this evaluation project were multiple:

- Accuracy in the prediction of the response of reinforced plastic using the Digimat model taking into account the local anisotropy resulting from the injection process
- Capability for multi-performance FEA : static and dynamic failure
- Flexibility by using 1 unique multi-scale material model with various FE solvers
- Effort to perform the material calibration



Impact test on a pre-production reinforced plastic front end carrier in the new Volvo XC90

"Digimat features local anisotropic response from the injection molding process. This increases the predictability of our CAE simulations used in the development of new vehicles at Volvo Car Corporation."

– Johan Jergeus, Volvo Car Corporation

Solution

- A local anisotropic Digimat material model has been calibrated from limited experimental data available on coupons. An injection simulation has been performed using Moldflow and the resulting fiber orientation field has been mapped onto the structural mesh.
- The final FE model is able to capture the material's anisotropic behavior dependent on the local fiber orientation now available on the structural mesh's finite elements.

Results/Benefits

- The accuracy of prediction has been proven for dynamic and quasi static load types
- Usability with different implicit and explicit FE solvers has been demonstrated
- Digimat parameters for Durethan BKV 30 (PA6 GF30) has been determined from the limited test data available

- IT Performances
  * Simulation of full crash loadcase (Pedestrian)
    - Reasonable 3-5 % increasing computational cost for replacing isotropic CrachFEM with local anisotropic Digimat in one component
  * Simulation of vehicle static strength loadcase
    - Decrease of computational cost for replacing isotropic Abaqus model with local anisotropic Digimat in one component

Results Validation/Correlation to test data

A pre-production version of a front end carrier for the new Volvo XC90 model has been chosen for this evaluation. 6 loadcases has been applied to this model:

- 4 on the front end carrier alone:
  - Quasistatic symmetric & asymmetric 3 point bending
  - Dynamic symmetric & asymmetric drop test
- 2 on a full car models : pedestrian crash, static strength.
- The simulation results obtained with the front end carrier model alone has been compared to experimental data. The results visible on figures 1&2 show a good prediction in terms of stiffness as well as strength for dynamic and quasi static loadcases with Digimat local anisotropic material model.

Key Highlights:

Digimat: Digimat-MF, Digimat-CAE

Company: Volvo Car Corporation / Dynamore Nordic

CAE Technology: Abaqus Standard, LS-Dyna Implicit and Explicit, Moldflow

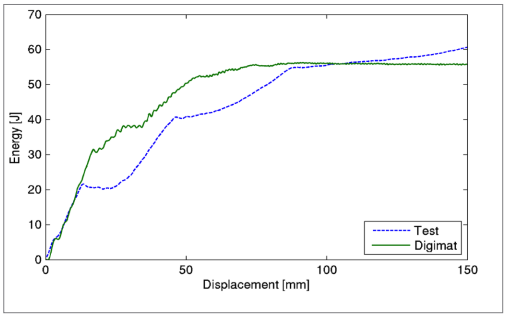
Material: SFRP

Industry: Automotive

Application: Front End Carrier: 3 point bending tests, full car pedestrian crash, full car static strength

Performances: Impact, static strength

Figure 1: Dynamic asymmetric drop test: Digimat material model used in a LS-Dyna FEA captures accurately the dissipated energy in the FEC compared to experiment



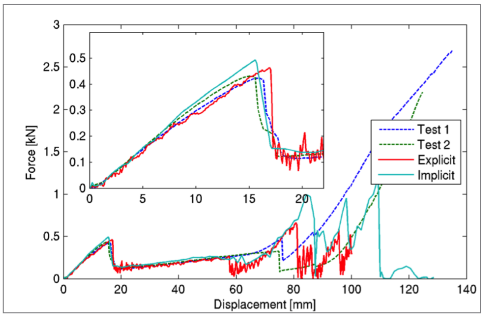


Figure 2: Quasi-static symmetric 3 point bending test: FEA Digimat & LS-Dyna captures accurately the maximum force at failure measured in the experiment

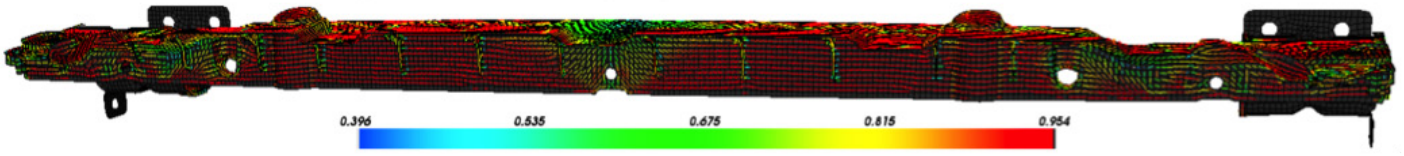


Figure 3: Fiber orientation throughout the FEC has been simulated with Moldflow and mapped onto the structural mesh to capture the local stiffness and failure behavior of the material

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

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