Case Study: **Acoustic Simulation of Anisotropic Injection Moulded Parts**

Development of new acoustic materials with viscoelastic & anisotropic polymers

Overview

As part of the European R&D project “Akustik-OPT”, the University of Applied Sciences South Westphalia, Fachhochschule Südwestfalen, Laboratory of integrated Product Development and Process Simulation (iPPS)assigned Dipl.-Ing. Michael Giess, Research assistant engineer and PhD Student, to work on the development of new acoustic materials with viscoelastic and anisotropic polymers in order to improve the prediction of structure-born sound transmission in a car.

Mr Giess has evaluated Digimat’s benefits to account for the effect of fiber orientation on the local anisotropic stiffness and damping properties of a glass filled polymer.

Two methods have been evaluated to model the material behavior:

- Global anisotropic: an anisotropic viscoelastic model is calibrated from Dynamic Mechanical Analysis (DMA) tests on composites samples at angles 0° and 90° to the fiber direction and applied homogeneously on the component’s mesh.
- Local anisotropic: a microstructure-dependent model is built with a viscoelastic resin calibrated from DMA test on resin alone sample and an elastic property for glass fibers.
- the model is associated with fiber orientation distribution mapped onto the component’s mes.

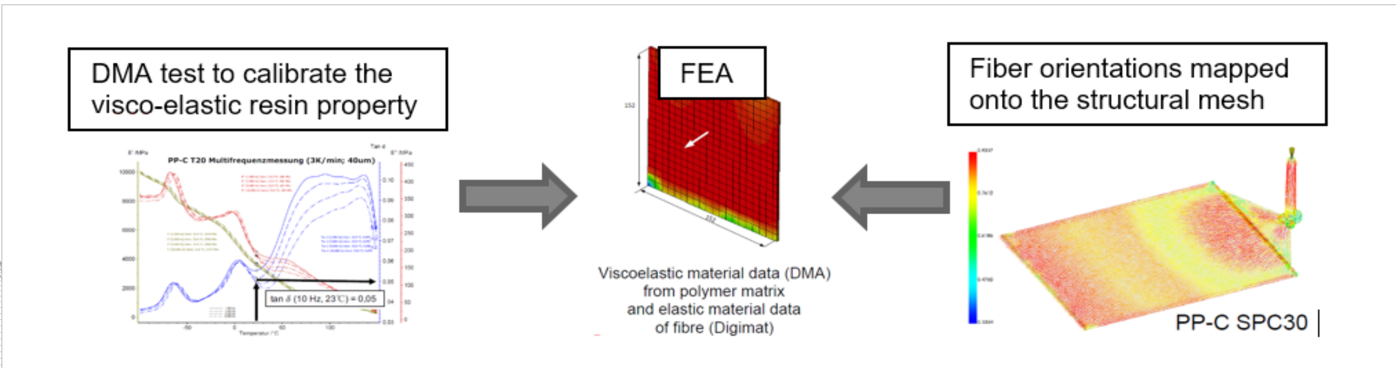
The two approaches has been applied on a frequency response analysis performed on a reinforced plastic plaque with two load cases for two loading directions and the results have been compared to experimental data.

Challenge

The vibratory behavior of fiber-reinforced polymers is dependent on the manufacturing process. On one hand, the stiffness is driven by the fibers. On the other, damping is linked to the resin’s viscous property.

At the composite level, the resulting trends are that stiffness tends to increase with higher fiber volume fraction and alignment. Inversely, damping will increase with lower fiber volume fraction and alignment.

In addition, the effect of frequency can also be important. Therefore, in order to predict accurately the vibrational behavior of a fiber reinforced plastic component, the influence of manufacturing process and frequency must be taken into account in the simulations.



“Digital material in Digimat-MF is a great opportunity to improve and optimize the acoustic behaviour of injection moulded parts virtually without any real prototypes. In addition, Digimat-RP in combination with process simulation and FE-simulation represents a good tool to calculate exact acoustic phenomena due to the orientation of fibers (structure-borne sound transmission).”

Mr Michael Giess, Research Assistant Engineer and PhD Student

Solution

A microstructure-dependent viscoelastic material model has been calibrated and applied in structural FEA:

The viscoelastic property for the resin has been automatically calibrated by loading directly in Digimat-MF test data from DMA performed on resin alone.

A standard value elastic property has been used for the glass fibers.

Fiber orientation and distribution has been predicted through an injection simulation and mapped onto the structural mesh.

Frequency response analysis has been performed on component accounting for the effect of fiber orientations and frequency on its stiffness and damping behaviors.

Results/Benefits

The efficient execution of the project has been facilitated by the capability to automatically calibrate the resin’s viscoelasticitic properties from DMA tests data in Digimat-MF and the user-friendliness of Digimat-RP to set-up a multi-scale FEA.

The comparison of FRF analysis results with experimental measurements reveals a better accuracy when using the local anisotropic model accounting for the effect of fiber orientations.

In particular, the prediction of damping behavior has been significantly improved with deviations going from 10% to 1% for load case 0°, and from 30% to 1% for load case 90° when comparing discrepancies with experiment between global and local anisotropic approaches.

Key Highlights:

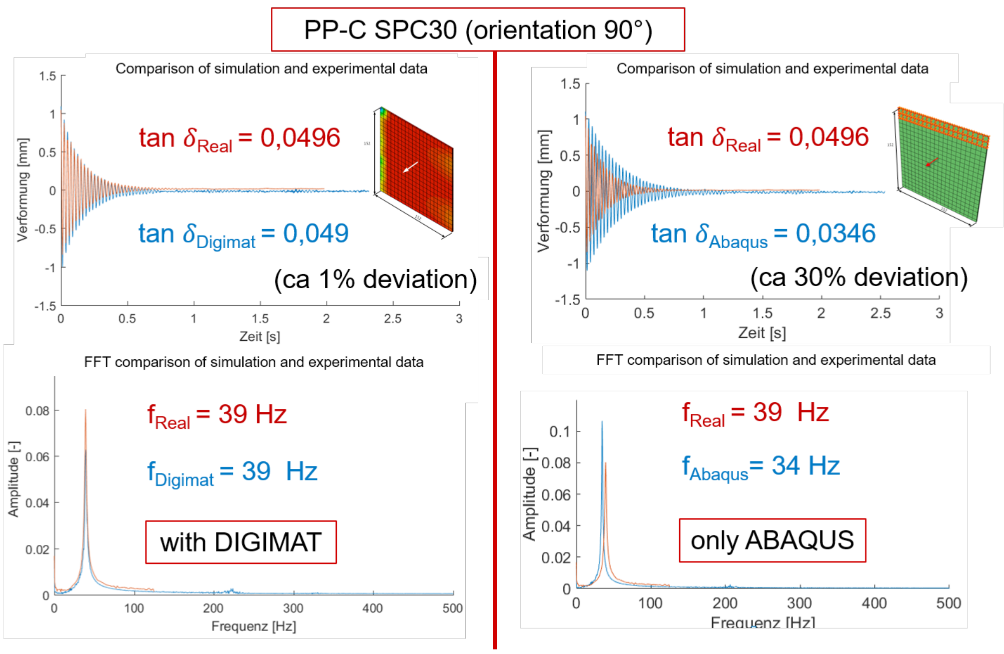
Products: Digimat-RP, Digimat-MF

Industry: Automotive

CAE Technology: Abaqus, Moldflow

Application: Damping prediction of a reinforced plastic plate

Performances: NVH



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

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