Title
CAE of Thermoplastic Woven Glass Composites (Organo-Sheet)

Jerome Coulton

Hyundai Motor Europe Technical Center GmbH, Rüsselsheim, Germany

1 Abstract

Thermoplastic woven glass composites have been identified for high strength with low specific weight and cost. In order to accurately predict and optimize part performance it is essential to have good quality validated material models. For thermoplastic woven glass composites this is a great challenge as these material are new on the market and there is a lack of openly available material test data and knowledge in how to use this data in simulation programs.
Two organo-sheet materials, with polyamide and polypropylene matrices, were modelled, validated and have been used for the structural performance a lightweight thermoplastic composite structure.
This paper describes the measurement of material properties, generation and validation of material models for both polyamide and polypropylene based materials. This was achieved in three phases: 1) basic material modelling and validation, 2) modelling and validation of hybrid parts, and 3) application and confirmation in real vehicle parts.

2 CAE Target Accuracy

In the generation of validated material models, for the design of the thermoplastic composite rear seatback, there were two main targets:

1. Increase CAE Accuracy: >90% (no break design)
   > 70% (including failure)
2. Compare polyamide and polypropylene based materials.

The target CAE accuracy at HMETC was based on the quoted accuracies of several OEMs at a recent conference in 2011 [1,2,3].

3 Method

The development of the validated material models was achieved in three phases:

1. Material modelling
2. Prototype part modelling
3. Real structure application

This is shown in Fig 1. Within each of these three phases there were three sub activities:

1. Testing
2. CAE modelling and simulation
3. Validation

4 Validation of FE Models

4.1 Correlation criteria

The results of the tests and simulations for the polyamide prototype parts are shown in Fig 2. The quality of the agreement, between test and simulation, was assessed using the **W**eighted **I**ntegrated **F**actor (**WIF**ac) Method [4]. This method results in a single value (0 – 100%) representing the accuracy of the match of 1) peak value, 2) timing of peak value and 3) shape of the curves.

4.2 Real Structural Part Accuracy

The real parts show very good agreement with the test results (Deformation 97%, Load 99%). Better in fact that for the prototype parts. This is due to the limited damage and cracking that is allowed for the design of the read seatback. The parts are primarily below the damage threshold where the CAE versus test accuracy is greater that in the post breaking and damage phase.

5 Figures

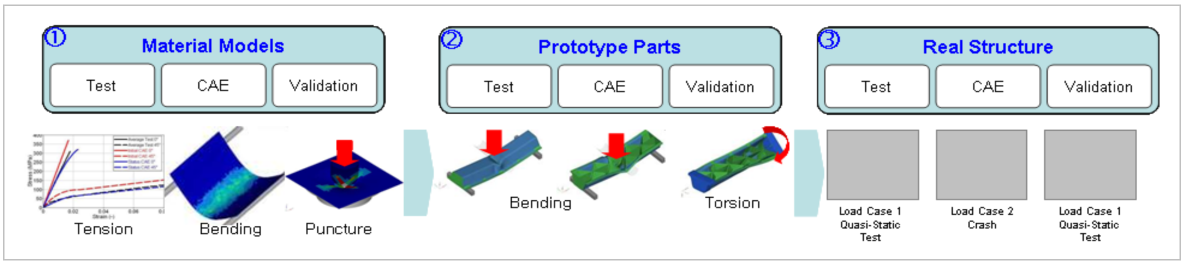
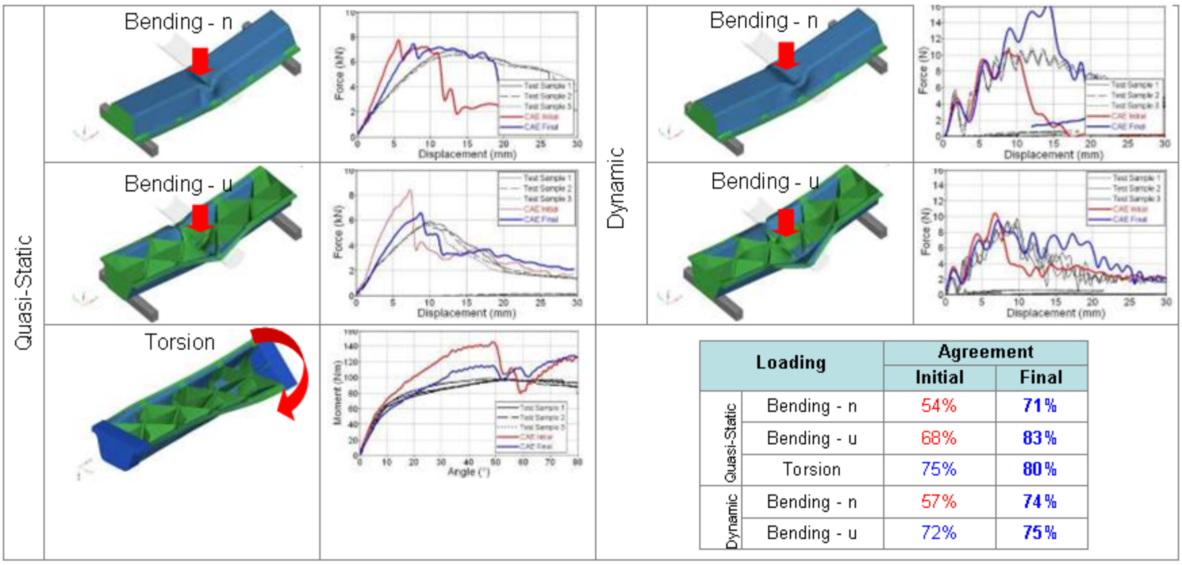


Fig. 1: Overview of modelling and validation process



	Loading	Agreement Initial	Agreement Final
Quasi-Static	Bending - n	54%	71%
Quasi-Static	Bending - u	68%	83%
Quasi-Static	Torsion	75%	80%
Dynamic	Bending - n	57%	74%
Dynamic	Bending - u	72%	75%

Fig. 2 Polyamide Prototype Part Accuracy

6 Summary

The major achievements were:

1. The generation of validated material model for woven glass composite materials. These models meet industry standards for accuracy and can be used with confidence for the design of novel innovative products.
2. Objective comparison of material systems via the manufacture of prototype parts (Erlangen Traeger).
3. Successful application of the data to the design of a real component with a resultant very good agreement with test results..

7 Literature

[1] Kögl M: "The challenges for simulating CFRP automotive structures", VDI Conference, Simulation im Automobilen Leichtbau, 2011

[2] Lescheticky J: "The Overview: Crash simulation i.e. failure of materials and joining technology at BMW", VDI Conference, Simulation im Automobilen Leichtbau, 2011

[3] Döll J: "The functional layout of chassis structures from fibre reinforced materials", VDI Conference, Simulation im Automobilen Leichtbau, 2011

[4] Hovenga P: “Improved Prediction of Hybrid-III Injury Values Using Advanced Multibody Techniques and Objective Rating”, SAE paper 2005-01-1307, 11 April 2005