Case Study:
Influence of fibre orientation in the design of a collector box ground cable retention feature

Company

Inteva designs and manufactures low-mass, low-noise, high-performance motors to primarily support window lift systems and roof systems. Design features of Inteva's portfolio include integrated electronics, anti-pinch technology; express up-and-down functions and Pulse Width Modulation (PWM) technologies.

Sunroof motor is an electro-mechanical device that takes electrical energy and converts it into mechanical energy. The motor assembly consists of several components such as worm shaft, magnet, collector box, stator-can, etc. The plastic collector box holds several electrical components, ground cables and retention features to engage with the stator-can in which magnets are placed. The ground cable retention feature of the collector box (as shown in Fig 1) was created to hold this cable in constant contact with the stator-can essential for the functioning of the motor. This retention feature is a flexible member with a small protrusion in the form of a hook or a bead, which is intended to deflect during assembly with the stator-can and always stay in pre-stressed condition.

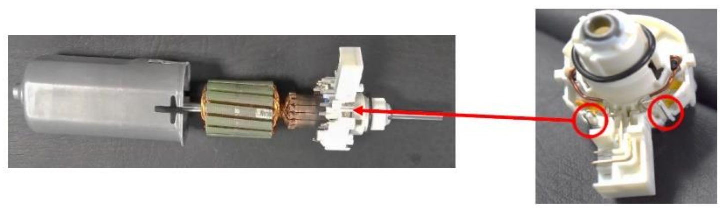

Figure 1: Collector BOX

Figure 2: Experimental setup to get retention forces

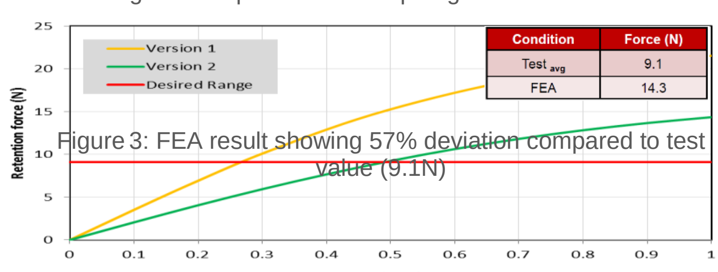

Figure 3: FEA result showing 57% deviation compared to test value (9.1N)

Challenge

The collector box ground cable retention feature was improved over the earlier design further for better performance. An economical and reliable feature was to be redesigned to meet the requirements of the intended retention force which ensures that the feature is always under pre-stressed condition. In the process of design modification of this existing feature, several parameters like length of the arm, width and thickness at the root, etc. were considered. The retention forces were estimated through a structural simulation using non-linear isotropic material properties (glass-filled Polybutylene Terephthalate material). The extracted retention force for this redesigned feature was found to be exceeding the intended force value which in turn caused the failure of the feature. However, the physical test results (As shown in Fig 2 and 3) showed that the features were safe, and the retention forces measured were also in the acceptable range. Hence to understand the influence of fibre orientation in such glass-filled components; extended FEA studies were carried out using Digimat software.

Key Highlights:

Product: Digimat

Industry: Electro-Mechanical devices

Challenge: Evaluate the strength of the retention feature during its assembly with the stator-can and satisfy the retention force requirement using Digimat coupled simulations

Solution: Anisotropic non-linear simulation, considering manufacturing effects and stiffness and strength predictions

Digimat Solution

Moldflow simulations were carried out on the collector box to understand the orientation of fibers particularly at the retention feature region. These orientation results were mapped on to the structural model (using Digimat-MAP) and the simulations were further carried out using Digimat-RP. The results now inferred that the retention forces were comparable with the test results and the features were safe.

The deviation compared to test results is 2.2% with Digimat (As shown in Fig 5).

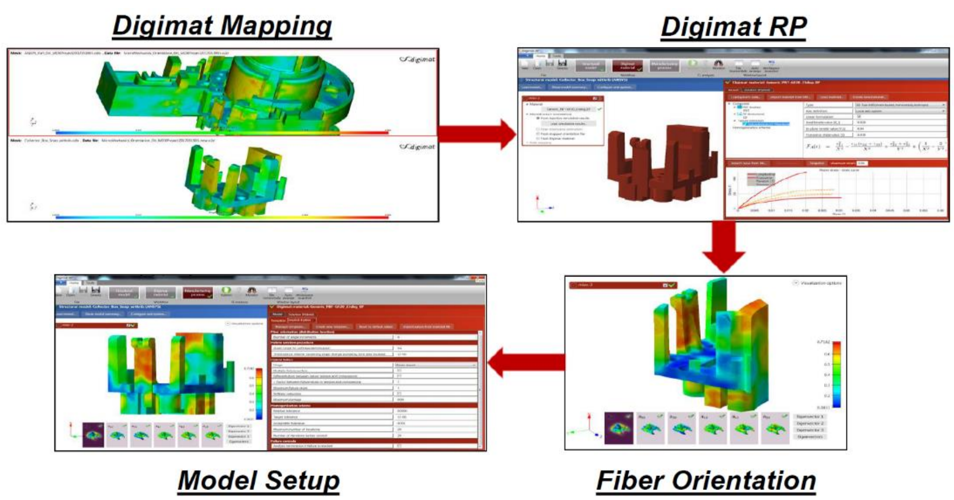

Figure 4: Fiber orientation mapping to structural mesh and performing the FEA in Digimat-RP

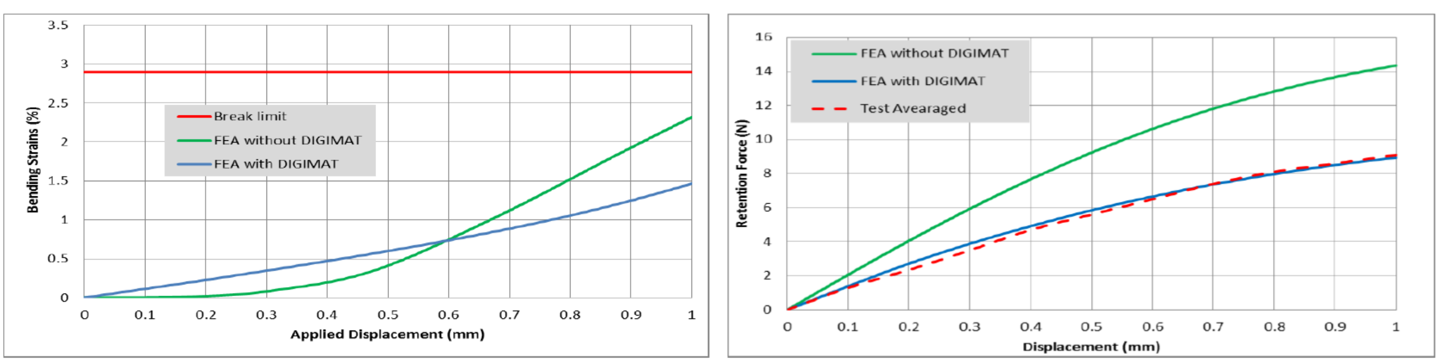

Figure 5: Comparing the Digimat coupled FEA plots with non Digimat results

Benefits

Finite Element Analysis with Digimat material model shows good agreement with physical test results. Retention force variation is 2.2% when compared to test results. FEA predictions for glass-filled parts are more accurate with Digimat. Fiber orientations play a significant role in determining the stiffness of glass reinforced parts. Hence, an integrated FEA approach involving Moldex3D, Digimat and ANSYS is found to be a recommended approach for evaluating glass-filled components

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

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