

Applications of a New Method for the Engineering of Endless Fiber Reinforced Body in White Components

Fang XF^{1*} and Grote M^{1,2}

¹Institute of Automotive Lightweight Design, University of Siegen, Germany

²MöllerTech Engineering GmbH, Bielefeld, Germany

Abstract

For development of efficient and economic car bodies, high performance lightweight materials such as endless fiber reinforced plastics (FRP) have gained importance. However, the systematic engineering and design with composite materials and hybrid combinations of FRP and metallic materials are extremely challenging. Therefore, the whole design process has to be supported with new methods, which should be applied in the early stage of body design to avoid wrong decisions.

Keywords: Economic car bodies; Metallic materials; Numerical optimization tools

Introduction

For development of efficient and economic car bodies, high performance lightweight materials such as endless Fiber Reinforced Plastics (FRP) have gained importance. However, the systematic engineering and design with composite materials and hybrid combinations of FRP and metallic materials are extremely challenging. Therefore, the whole design process has to be supported with new methods, which should be applied in the early stage of body design to avoid wrong decisions.

In the study of Fang and Grote [1], a novel method for developing a multi-material body in white concept with composite material or hybrid material system was introduced. This method is based on the work of Durst [2] which considers the anisotropy of the current stress states. The anisotropy is described with a so-called anisotropy value that can range between zero and one. Hereby, a higher value stands for a higher anisotropy according to the loading conditions of the considered component.

This value was used and applied in several studies during the last years [3-5]. One main drawback of this approach is that it is primarily helpful for the identification and less for the engineering design of endless fiber reinforced components. The main target of Fang and Grote [1] is to develop a new method, which may identify and evaluate FRP suitable components in a body in white and re-designs them in a new FRP design at the same time.

Discussion

In the first step of the newly developed method, the anisotropy of the components is analyzed to pre-evaluate the potential of FRP suitable parts. In the second step, the pre-dominating orientation of every single finite element is determined and clustered to get a first impression of an appropriate laminate architecture. Furthermore, a visualization subroutine is implemented to illustrate the results. These results can be used to identify contiguous areas with the same pre-dominating orientation that is very helpful for the development of hybrid material components. In the last step, a suitable design with a preliminary stacking sequence is calculated. These values can be used as a starting value for numerical optimization tools.

To prove the feasibility of this method, it has been applied on the body in white of a full electric vehicle. With the help of finite element

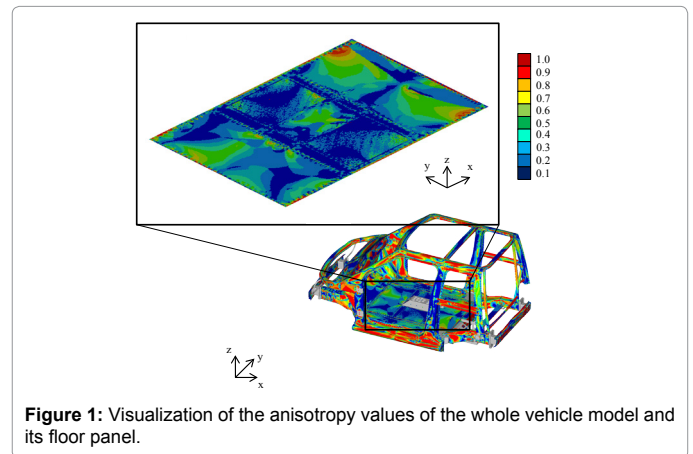


Figure 1: Visualization of the anisotropy values of the whole vehicle model and its floor panel.

simulations the global torsion and bending stiffness has been analyzed. In the following, two different components will be considered in detail.

The anisotropy for the floor panel is shown in Figure 1. The illustration shows rather low anisotropy values close to zero in most of the areas of this component. This result indicates a low lightweight potential for this component.

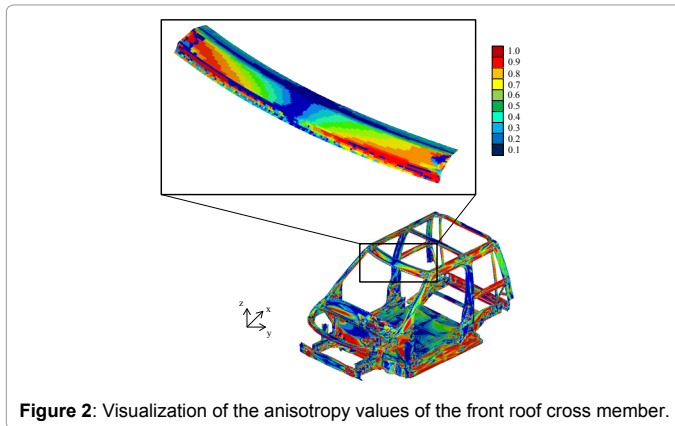
Figure 2 shows the illustration of the anisotropy value of the front roof cross member. It is obvious that there are highly anisotropic areas in this part, especially in the lateral areas. With the use of the newly developed algorithm in the study of Fang and Grote [1] a tailor made design for a carbon fiber reinforced solution of this component has been developed.

***Corresponding author:** Fang XF, Institute of Automotive Lightweight Design, University of Siegen, Germany, Tel: 0049-271-740 4670; E-mail: xiangfan.fang@uni-siegen.de

Received February 11, 2018; **Accepted** February 14, 2018; **Published** February 19, 2018

Citation: Fang XF, Grote M (2018) Applications of a New Method for the Engineering of Endless Fiber Reinforced Body in White Components. Adv Automob Eng 7: 179. doi: 10.4172/2167-7670.1000179

Copyright: © 2018 Fang XF, et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.



Conclusion

Additional finite element simulations have been performed to

evaluate the global torsion stiffness of the whole body in white with this new design. In comparison to the reference design in steel, the new design has achieved almost 75% weight saving by sacrificing only 0.8% stiffness.

References

1. Fang XF, Grote M (2017) Development of a method for the identification and engineering design of endless fiber reinforced components. *International Journal of Automotive Technology* 5: 861-873.
2. Durst KG (2008) Beitrag zur systematischen Bewertung der Eignung anisotroper Faserverbundwerkstoffe im Fahrzeugbau. Ph.D. thesis. University of Stuttgart, Germany.
3. Albers A, Schmid A, Zhang Q, Grönheim J, Schipperges J (2012) A CAE-based concept for the automatic identification of lightweight components in the overall system. *NAFEMS Online – Magazine* 3: 54-63.
4. Klein D, Witzgall C, Wartzack S (2014) Evaluation and optimization of the fiber composite suitability of lightweight structures in the early stages of product development. *NAFEMS Online – Magazine*. 4: 55-66.
5. Grote M, Fang XF (2015) Development of a front body concept in a steel-GRP composite construction. *ATZ- Automotive Journal* 10: 62-66.