

Popular Science Report

Design of cost-efficient joining solution for a composite-metal structure

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With an increasing awareness of environmentalism, the transportation sector is also understanding its duty to protect the natural resources given to humankind. For the sector it is increasingly important to decrease the weight of transportation vehicles to save fuel and electrical energy. For a severe weight reduction Volvo Buses plans to launch a lighter bus structure in the following years. This work deals specifically with a novel composite rear cap (the back of the bus). To illustrate the design process in short, the popular summary is structured in material descriptions (A), the overall purpose of the work (B), a description of the designs (C) and how the work was evaluated (D)

- (A) The rear cap consists of a sandwich structure made of polyurethane foam (PUR) with glass fibre reinforced plastic skins. It is called sandwich structure as the light core is surrounded by two thin and stiff skins.*
- (B) The purpose of this work is to design joining concepts between the Sandwich Structure and the metal frame/ chassis of the bus. The work is restricted by several constraints given by Volvo, which includes among other things low production costs and the production method. There are 4 different design concepts created and evaluated. The concepted designs include inserts in the sandwich structure, adhesives used on the skin of the composite, metal flaps introduced in the core material and a micro pin solution that is introduced in the glass fiber layer of the sandwich structure.*
- (C) Inserts are cylindric metal structures with a threaded hole. They are installed in the sandwich structure and are then mechanically attachable with bolts. For the adhesive concept metal plates are directly glued towards the skin of the sandwich structure. These plates can be attached with hex nuts and bolts to the rest of the bus. For the metal flap concepts small metal T-bars are inserted in the core of the sandwich and locked by the glass fibre skins. This concept is also attachable with bolts and hex nuts. The last concept is the micro pin concept. For this design a metal T-bar is connected only to the skin of the sandwich structure. It is held by hundreds of small micro pins on the surface of the T-bar that are introduced to the composite skin. This concept is based on the most novel approaches of joining composites with metals.*
- (D) The evaluation includes a numerical analysis on if and how the composite withstands applied loads from the introduced joints. It also describes failure modes that need to be considered for in-depth analysis of the designs. Further the designs are compared from a cost perspective. The final design decision is based on a multi objective decision analysis. It compares the weight, costs, mechanical behaviors, and other constraints of the designs simultaneously. The analysis results in the recommendation on choosing the Adhesive Design to introduce as the preferred joining option. As the work only gives a preliminary design, the Adhesive Design must be analyzed and adopted more precise before introducing it in a final product.*

