Chapter 11
Optimization of Seat Frame With Dissimilar Materials for Lightweight Materials

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ABSTRACT

High-strength and lightweight methods for vehicle parts include methods such as optimization and application of lightweight materials by reflecting load or material characteristics. Safety regulations have been established in accordance with the loads affecting the vehicle to secure the safety of the vehicle. In order to reduce the weight, high strength materials such as high strength steel (HSS) or high tensile strength steel (AHSS) have been studied. In addition, research on additional lightweight optimization is actively performed by removing parts that do not require high strength or replacing them with plastics. The process of designing a vehicle or part with different properties and considering various loads is costly and time consuming. In order to secure safety and lightweight, the authors propose an approximate model for the optimal design of the seat frame that has a direct impact on occupants among the parts of the vehicle, and reduces the development cost, time, and intuitive design through the procedure.

INTRODUCTION

Consider a Variety of Materials

As the automobile industry advances, lightweight vehicles are being developed to improve fuel efficiency while increasing the strength of the vehicle’s body and the internal components, in addition to enhancing passenger safety (Jeong, Oh, & Cheon, 2016). Among the numerous important components of a vehicle, the seat not only supports the human body, but also has a direct impact on the passenger due to

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external shocks. Therefore, the seat frame should have sufficient strength (Cho et al., 2013). Through shape and strength design of the seat frame, we are actively developing a new seat that conforms to the automobile test regulations. A study on the optimization of the seat frame made of lightweight material that can replace the typical steel seat frame is necessary.

The research on the weight reduction of automobiles is divided into the method of increasing the strength and reducing the weight by changing the material applied to the existing automobile, the method of reducing the weight of the automobile body structure, and the method of reducing the weight by applying the new construction method in the manufacturing process (Jang, Yeom, & Lim, 2018). Structural weight reduction can be achieved by improving the design of the vehicle body through optimization of components and modularization, and can be made lighter by utilizing new construction methods for welding and joining in manufacturing. In the case of material weight reduction, a method of applying to a component by applying a lightweight material having excellent physical properties mainly on a composite material such as plastic, aluminum, and magnesium has been developed. In addition to the method of lightening the structure of the car, among the lightening methods of the car, the part about the lightening of the car seat is also an important lightening method.

A lightweight seat frame not only has a reduced mass, but it also has the strength that is appropriate to the material. Thus, the aforementioned factors have stimulated the investigation of lightweight seat frames. Compared the frame stiffness with thickness using high-strength steel (HSS), which has a strength greater than that of typical steel (Kim, Cho, Kim, & Cho, 2014). Confirmed that high-strength plastic materials could be applied to the seat frame to make it lightweight, while achieving a strength comparable to steel (Kim, Lee, Yang, & Kang, 2016). Performed optimization experiments for the seat cushion structure with HSS using design-of-experiment (D.O.E), based on the thickness of the HSS (Jung, Lee, Kwon, & Han 2010). Conducted a lightweight design for bulk trailers using topology optimization to reduce fuel costs and effectively respond to environmental regulations (Kim et al. 2017). Conducted an optimal design using topology optimization for the review of structures that can be lightweight while ensuring the safety of railway vehicles and parts as transportation machines (Han & Jung, 2011; Hwang et al., 2003).

Consider a Variety of Loads

As environmental regulations for automotive exhaust gas are intensified, there is growing interest in high-strength and lightweight design methods for automotive components. In general, such high-strength and lightweight design requirements can be met using high-strength and lightweight materials. As safety can be lowered by material or structural changes, however, it must be ensured after applying the combined tensile, compressive, shear, twisting, bending, and impact loads in accordance with the ASTM, ISO, EEC, ECE, and FMVSS regulations.

An example of a structure under combined loads is a seat frame.

The load applied to the top of a seatback frame generates a moment that leans the seat backward; the combined loads considered in this test are tensile, compressive, and bending loads. Regulations for assessing safety against excessive tensile, compressive, and bending loads are FMVSS 207 (Salim et al., 2013; Lim, 2017; Kim, & Lee, 1999; Lee et al., 2005) and FMVSS 202a (Jang & Min, 2005; InterRegs Ltd, 2012). Tests for tensile, compressive, and bending loads are classified as static tests, and they assess safety using the maximum displacement determined by the regulations.