Improving the Dynamic Characteristics of Body-in-White Structure Using Structural Optimization

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The dynamic behavior of a body-in-white (BIW) structure has a significant influence on the noise, vibration, and harshness (NVH) and crashworthiness of a car. Therefore, by improving the dynamic characteristics of BIW, problems and failures associated with resonance and fatigue can be prevented. The design objectives attempt to improve the existing torsion and bending modes by using structural optimization subjected to dynamic load without compromising other factors such as mass and stiffness of the structure. The natural frequency of the design was modified by identifying and reinforcing the structure at critical locations. These crucial points are first identified by topology optimization using mass and natural frequencies as the design variables. The individual components obtained from the analysis go through a size optimization step to find their target thickness of the structure. The thickness of affected regions of the components will be modified according to the analysis. The results of both optimization steps suggest several design modifications to achieve the target vibration specifications without compromising the stiffness of the structure. A method of combining both optimization approaches is proposed to improve the design modification process.

1. Introduction

The dynamic characteristics of a body-in-white structure of a car are important in the design phase. Initially, for most structures undergoing dynamic loading, it is essential to know the natural frequencies and the corresponding mode shapes [1, 2]. The dynamic behavior of a structure can be predicted by knowing the characteristics. By understanding how a structure would react under certain frequency, a number of improvements can be implemented in a design. In such cases like the BIW, the modification of the body needs to be considered in NVH while also focusing on the ride [3], handling [4], and safety of the user. Failures could occur due to resonance or fatigue which can be avoided by identifying the resonance regions and operating frequency of the structure [5].