Development of jounce-support bumper assembly with increased energy absorption rate to improve vehicle driving performance

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This study was carried out to predict the damping performance of vehicle's jounce bumper using Finite Element Analysis(FEA). In the past, the jounce bumper simply acted as a stopper to protect the shock absorber, so it was used as a safety device to protect the strut complete by stopping at the height required for compression. However, nowadays, it is expanding its role not only as a safety device but also to improve driving performance and ride comfort. Therefore, the jounce bumper improves the noise, vibration and harshness (NVH) performance of the vehicle by offsetting the impact energy and vibration frequency transmitted from the road surface in the high speed and impact sections[1]. In order to improve the driving performance, the limit speed of the corner must be increased. To do so, the rolling of the vehicle must be reduced. In order to reduce this rolling, the energy absorption of the jounce bumper is an important factor. There is a limitation in increasing the energy absorption amount at high speed while maintaining the initial stiffness in the low-speed traveling mode only by the single-component bounce bumper. To overcome the limit of energy absorption, a Dual Rate Jounce Bumper was developed[2]. However, it works only when an excessive impact is applied to the vehicle, thereby mitigating the impact amount. Therefore, this technology can't escape the inverse relation of ride comfort and NVH. In this study, we developed a support bumper which will help the energy absorption of the bumper. The application of the support bumper not only helps to absorb energy but also has the advantage of controlling the amount of energy absorption according to the driving mode. For example, Fig. 1 is a graph of the energy change characteristics by applying a support bumper to a jounce bumper. By applying the support bump, it is possible to improve the ride comfort and NVH performance by further increasing the energy absorption amount when moving from the high speed to the impact area. Therefore, this study aims to improve the NVH performance and the high - speed driving performance by making the jounce bumper and the support bumper assembly.

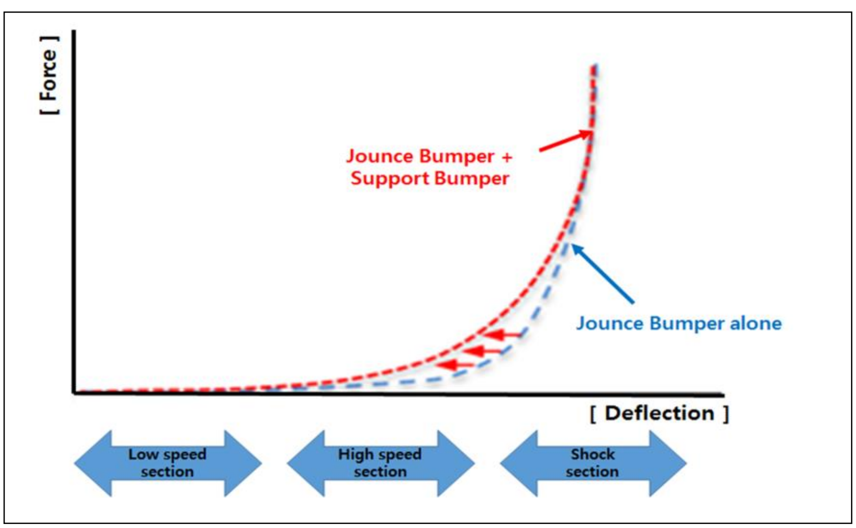
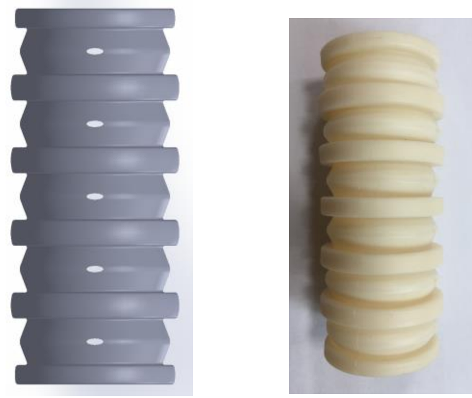


Fig. 1: Load-Deflection characteristic curve of jounce bumper and jounce bumper assembly

The proposed support bumper model is shown in Fig. 2. The material of the support bumper is TPE (Thermoplastic Elastomer), which has rubber and industrial plastic properties. The most important feature of this material is the strong elasticity and rigidity of the material. So this material is good for fatigue and strong durability and good for use in large deformation cycles[3]. The initial proposed bumper was verified by comparing the simulation model with the data through the LD characteristic test. The optimized simulation model was used to optimize the amount of energy absorption. The regression model function was estimated using the response surface method and the central composition method. The estimated regression model function was validated from the ANOVA table.



(a) CAD model (b) Test model

Fig. 2: Support bumper model

Jounce bumpers are made of TPU (Thermoplastic Polyurethane) with high strength, durability and energy absorption. The Mooney Rivlin coefficient is a coefficient representing the superelastic material constant such as TPU. The Mooney Rivlin strain energy function is defined as Eq. (1). The jounce bumper is also verified by comparing the simulation model through the LD characteristic test. The validated model proceeds with the same process as the support bump.

$$\mathrm{U} = C_{10}(\overline{I_1} - 3) + C_{01}(\overline{I_2} - 3) + \frac{1}{D_1}\left(J^{el} - 1\right) \tag{1}$$

Finally, we analyze the energy absorption amount according to the position of the assembled structure of the optimized bounce and support bumper. The two parts complement each other and find the position of the assembly structure that can perform well. Depending on the position of the assembly structure of the two parts, the required energy absorption in the low-speed, high-speed running mode can be adjusted. In addition, it can play an important role in relieving the excessive shock in the impact region.

References

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