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Characteristics of Vibration and Noise from Vehicle Seat Rail

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Abstract. This study performs experiments on the power seats being used today to analyze the characteristics of the power seat operating noise. First, the main noise frequencies were determined by analyzing the color spectrum of the power seat operating noise. Then, in order to analyze the slide rail's vibration pattern, modal tests were performed by location of the slide rail to determine the FRF curve and the mode shape. As a result, the main noise factor turned out to be the 9th order of motor rotation and the mode shape showed that cantilever-shaped motion occurs at the front part of the left upper rail.

Keywords: Color spectrum, FRF, Modal test, Mode shape

1 Introduction

The growth of the automotive industry shifted the focus from the mechanical aspect of technology research to the customer-sensitive quality technology and the importance of ergonomics is continuously rising. Therefore the automotive industry has passed through industrialization and information computerization to now reach a new paradigm of sensitive culture, and to meet the needs of this culture, various technology development and research are already underway [1,4]. In particular, the seat is a core module that causes decreased satisfaction because they are always in contact with the customer and various vibrations and noises that occur during operation are transferred directly to the body [2,3]. Among them, the operating noise of the power seat slide rail has many noise factors that are compounded such as

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bearing, reduction gear, friction, motor rotation, resonance, and shock, making it extremely difficult to perform noise characteristic analysis [5]. Therefore, this paper determined the vibration characteristics of the power seat slide rail at different locations in order to analyze the operating noise.

2 Test method

This study used driver seats of vehicles that are commonly used today. First, the slide rail's forward-to-backward operating noise was measured in a semi-anechoic chamber that has under 25dB(A) of background noise. As seen in Figure 1, the microphone is placed 700mm above the seat cushion and a 75kg dummy was placed on the seat to simulate the load condition. In order to analyze the vibration characteristics of rails at different locations, 5 3-axes accelerometers were placed on the upper rail and the lower rail as seen in Figure 2 to perform the modal test. For the location of the seat, the length of the rail was divided into 5 sections of 70mm.

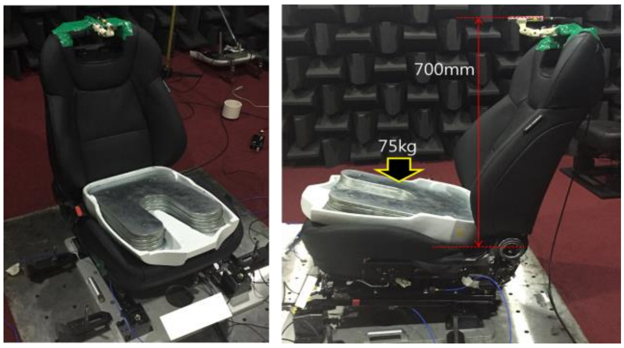


Fig. 1. Test set up for measurement of seat slide operating noise.

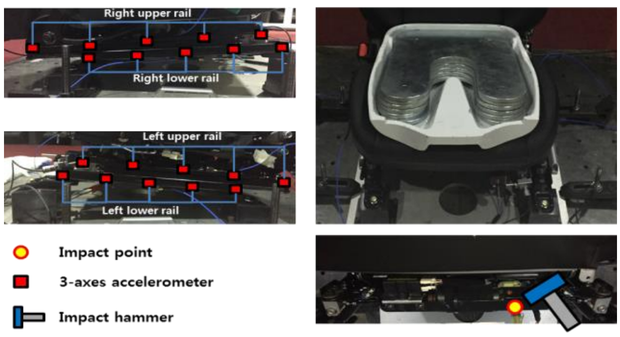


Fig. 2. Test set up for the modal test of seat slide rail.

3 Test result and analysis

The color spectrum of the vehicle power seat slide rail operating noise is shown in Figure 3. The harmonic components of the motor rotation was most vividly noticed when the operating noise frequency was under 500Hz. Among them, the 9th order of motor rotation was the highest when the seat moved from full backward to full forward.

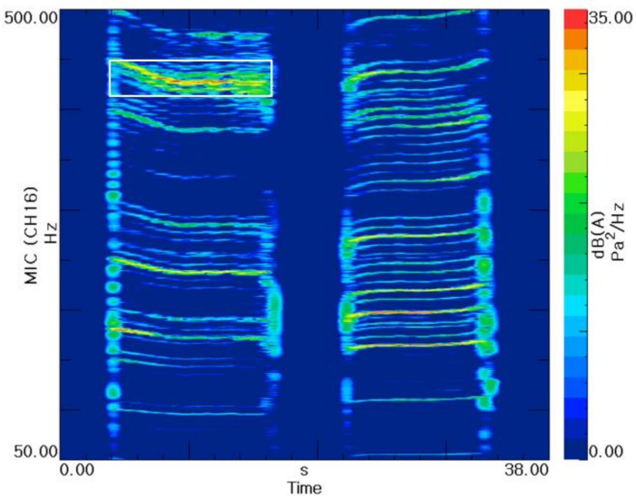
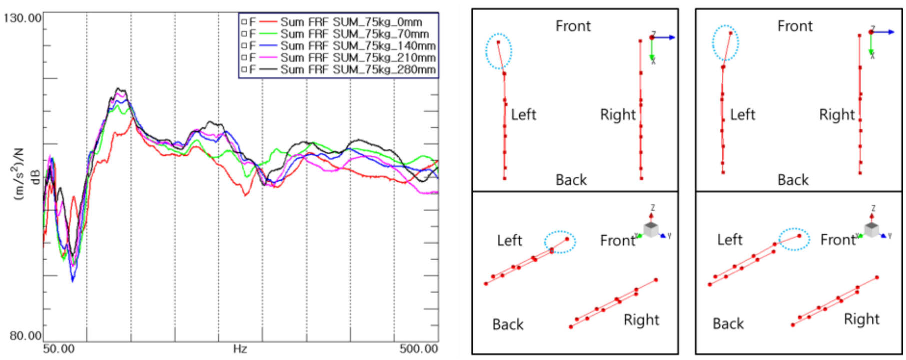


Fig. 3. The color spectrum of the measured operating noise.

Figure 4 (a) and (b) are the FRF curve and the mode shape around 9th order of motor rotation of rails at different locations, and it can be seen that a cantilever-shaped motion occurs at the front part of the left upper rail.



(a) FRF curve of each rail position (b) Mode shape(9^{th} order_motor rotation)

Fig. 3. Results of the modal test.

4 Conclusion

This study used a color spectrum to analyze the operating noise of power seat rails and determined that the 9th order of motor rotation is the most noticeable noise frequency. The FRF curve for different operating ranges was rendered through modal tests and the mode shape of the 9th order of motor rotation was determined.

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