Reduction Technologies of Rear Differential Gear Whine Noise by Controlling Vibration Characteristics of Leaf Suspension

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In recent years, commercial vehicles has been demanded to be same quality as passenger vehicles. Quality means not only for exterior and interior but also its quietness. It should be noted in the improvement of quietness that the reduction of background noise makes it easier to hear the sticking out noise such as differential gear whine noise. Since the differential gear whine noise of commercial vehicles is greatly affected by the variation in the vibration characteristics of the leaf suspension, measures are taken by applying mass such as a dynamic damper considering this variation. The purpose of this paper is to develop a method to improve the vibration characteristics of the leaf suspension without depending on mass. We propose a method that is highly effective in reducing the variation and a method that easily changes the resonance frequency and antiresonance frequency of the leaf suspension.

A method of reducing the variation in the vibration characteristics were examined using the leaf suspension evaluation bench which can reproduce the deformation of the leaf suspension by applying a load according to the loading conditions of the vehicle. For leaf suspensions randomly selected from the current product, the vibration characteristics and the contact state of leaf springs were measured for each load, and the variation in the frequency characteristics were analyzed. As a result, it was found that the factor was variation of two contact states. One is the contact state between the leaf springs when the load is large. The other is the contact state between the leaf spring and the abnormal noise prevention resin silencer when the load is small. Therefore, with the intention of ensuring a stable contact state regardless of the load, the contact material was press-fitted into two places between the leaf springs. As a result, it was possible to suppress variations in the vibration characteristics of the leaf suspension.

A method of controlling the resonance frequency and antiresonance frequency of the leaf suspension with respect to the peak frequency of the compelling force using the contact material was examined by simulation. The insertion position of the contact material was determined with reference to the eigen mode of the leaf spring, and was inserted in only one place to facilitate frequency control. Figure 1 shows an example of antiresonance frequency control. The antiresonance frequency is generated and close to the peak frequency of the compelling force of 410Hz. Figure 2 shows the insertion position of the contact material and two eigen modes that are opposite to each other after the contact material is inserted. The antiresonance is generated by arranging these two mutually opposite eigen modes so as to sandwich the peak frequency of the compelling force. This result was verified using the leaf suspension evaluation bench and an actual vehicle, and same result as the simulation could be obtained.

By applying either of the two methods proposed in this paper to actual vehicle, the differential gear whine noise affected by the leaf suspension can be improved.

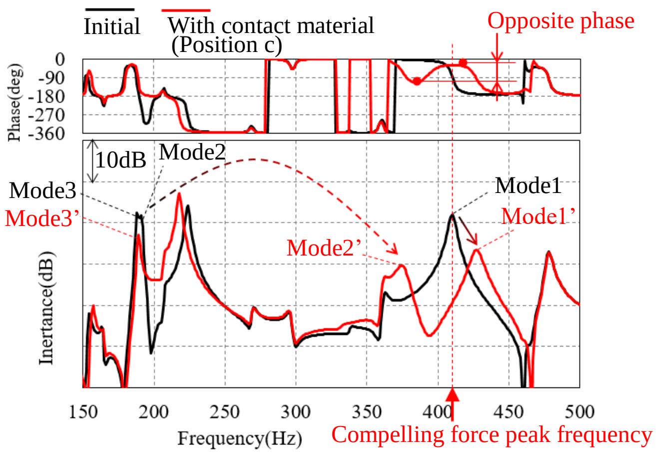

Fig.1 Peak level reduction effect by antiresonance

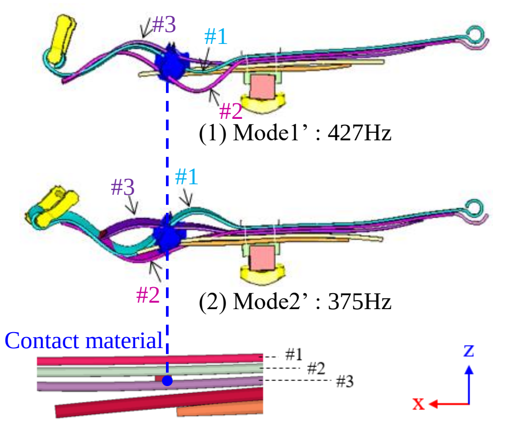

Fig.2 Eigen mode of leaf suspension