

Research for Brake Creep Groan Noise with Dynamometer

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ABSTRACT

This paper deals with creep groan noise in vehicles which is a low frequency vibration problem at 20~500Hz that appears in low brake pressures and extremely low speed especially in automatic transmission car, where there is a transition from static to dynamic condition. The vibration causing the noise is commonly thought to result from friction force variation between brake disc and pad in stick-slip phenomena. Simulation results are confirmed through dynamometer testing. Then presented noise contribution factor analysis by experimental approach between chassis components.

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INTRODUCTION

Creep groan noise is generated when a brake pedal is slowly released in an automatic transmission car which is initially stationary. Creep groan also occurs at low brake pressures, when a car is driven slowly (about 0.01 ~ 0.05kph). Stick-slip phenomenon of friction material and disc, and the structural dynamics of a car are related to this. Stick-slip phenomenon is caused by the difference in frictional coefficient between static state and dynamic state, and this leads to momentary change in braking force. This phenomenon becomes a vibration source, and causes the vibration to the entire chassis platform and body, as well as brake, and generates noise that offends the ears of passengers.

Until now, evaluation of creep groan noise has been conducted through real car test driving. In the event of a problem, the improvement of friction material was the most effective. Thus, in the early development stage, the evaluation was conducted before other tests. Meantime, it is likely that there will be a large variation in findings in accordance with temperature, humidity, and soaking time on the day of test driving. In addition, the change in creep drive torque according to engine specification and the evaluator can cause errors. This paper measured the interior noise in the event of creep groan noise, using a chassis dynamometer facilitating the control of temperature and humidity, and the drive and the brake of a car, in order to increase the reliability in evaluation.

The understanding of stick-slip phenomenon was improved based on the findings about vibration, and the noise and the frequency band measured by dynamometer, and then the influence of stick-slip on creep groan was analyzed. In addition, through ODS analysis, the vibration mode in the main frequency band for creep groan noise was analyzed. The differences in the vibration and noise level about the specifications compared through the analysis of the attributes of vibration depending on the transfer path from vibration source to chassis platforms and body, and the causes of the differences were investigated. Lastly, the improvement of creep groan noise not only by friction material but also by noise reduction through the modification of the attributes of other components was sought after.

Analysis of Creep Groan Behavior

Evaluation with dynamometer

In this paper, car's behavioral attributes in the event of noise was analyzed in order to work out a way to improve creep groan noise. In order to objectify the repeatability of reappearance and increase the reliability in the findings from an evaluation, a chassis dynamometer was used.

In order to find appropriate environmental conditions for an evaluation of creep groan, the interior noise by temperature, humidity and soaking time was measured. As a result, environmental conditions were set at 10 °C which generates the highest noise level, RH 85%, and 12-hour soaking which stabilizes noise variation.

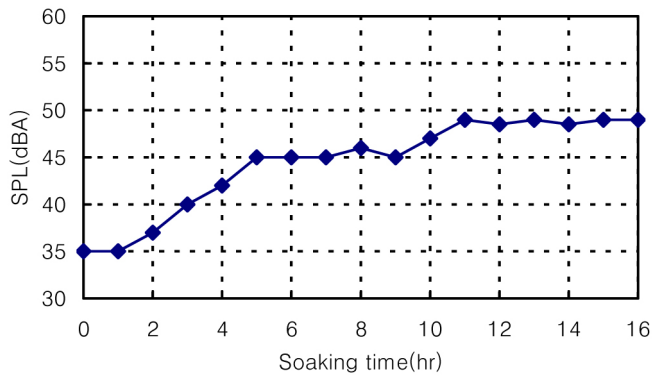


Figure 1. Findings from the measurement of interior noise by soaking time

With respect to the drive and the brake conditions for a car, in order to reproduce the conditions for the occurrence of creep groan in Just Slip evaluation mode during real car test driving, brake pressure was maintained at 3bar as shown in Figure 2 and then the speed of a car was increased or decreased at consistent acceleration for 30 seconds. And then, the interior noise on the driver's seat was measured.

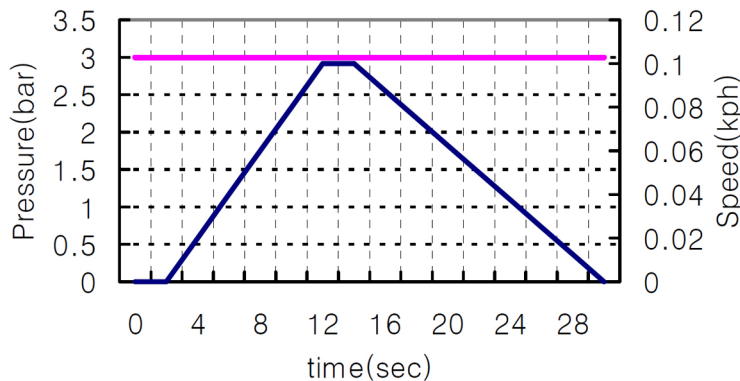


Figure 2. Conditions to reproduce dynamo creep groan

Attributes of creep groan behavior

Creep groan problems are generated as either vibration or noise, transmitted via a variety of paths, and then radiated acoustically into the cabin. These are classified as “structure-borne” noise. Thus, creep groan transfer path in which the vibration generated due to the difference in the static/dynamic frictional coefficient between brake disc and friction materials was brought into the car through the body can be considered mainly as shown in Figure 3.

- Path 1: Knuckle ->Lower arm ->Frame FRT MTG ->Body
- Path 2: Knuckle ->Lower arm ->Frame RR MTG ->Body
- Path 3: Knuckle ->Strut->Body

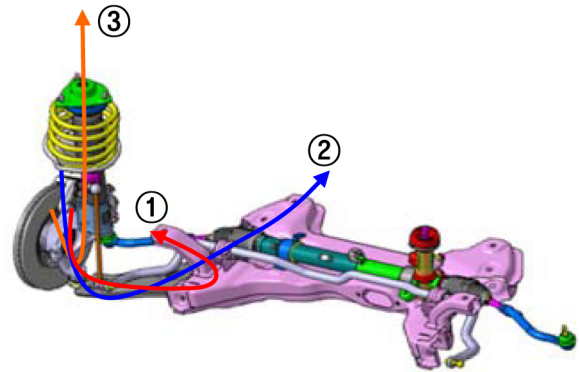


Figure 3. Creep groan transfer path

In order to analyze the attributes of creep groan behavior, 16 accelerometers were attached to the car and 1 microphone was attached to driver's seat as shown in Figure 4.

As a result of the measurement of the vibration of friction materials in the event of creep groan noise for model car 'A' under the conditions set in above section, stick and slip occurred repeatedly as shown in Figure 5. In addition, it was also known that in the event of slip, the vibration in entire frequency bands was being applied to brake system as in impact test. Creep groan generates slip at a consistent time gap (approximately 0.06sec(18Hz)) and this also appears in spectrum as shown in Figure 6.

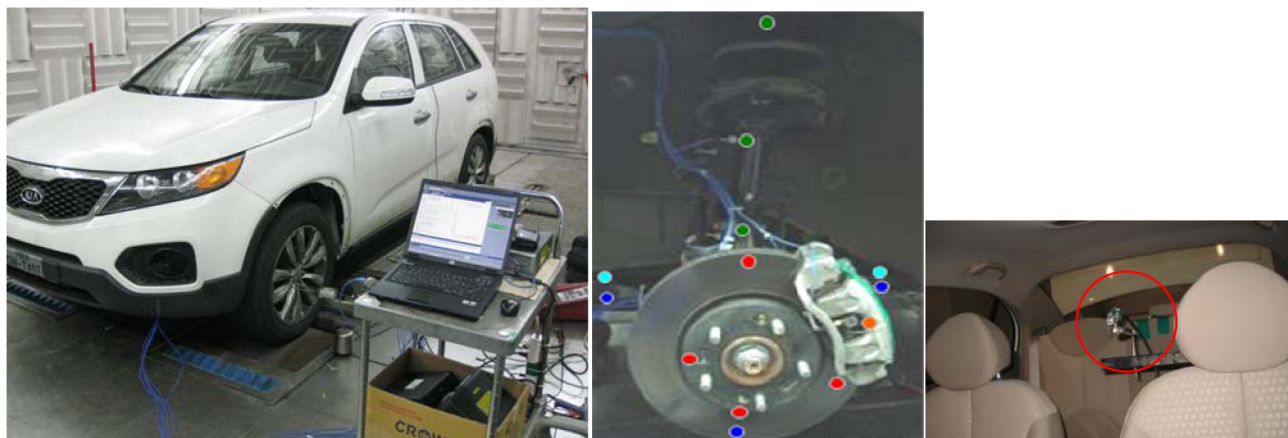


Figure 4. Positions of accelerometers and microphone