



NVH Application Note

NVHAN-035 Investigation and Resolution of Off-Brake Noise

Link Engineering has over 25 years of experience in Noise, Vibration, and Harshness (NVH). Whether you need a complete NVH test system, a laboratory screening of brake system NVH performance, vehicle subjective testing, or a fundamental NVH investigation, we have the experience and expertise to assist you. Please do not hesitate to contact Jim Thompson at 734-453-0800 or sales@linkeng.com. To learn more about our NVH activities and expertise, visit our website at www.linkeng.com.

Introduction

What follows is a brief description of a recent NVH program that involved an unusual problem. In this instance, Link was able to identify the problem and to assist with the development of a problem resolution.

Off-Brake Noise Problem

A client asked Link to provide assistance with a difficult production vehicle off-brake noise problem. A disturbing low frequency noise was occurring when slowly accelerating from a stop in some traffic conditions. The client was not sure of the cause of the problem and asked Link to identify the source of the problem as a first step.

Subjective Evaluation

The first step in this program was to subjectively experience the problem noise on the road. The problem noise was clearly objectionable in the vehicle interior and audible outside the vehicle. It was quickly discovered that the problem occurred when the brakes were heated to higher operating temperatures and with slow acceleration from a stop. Also, the noise was emanating from the region of the rear brakes.

Initial Problem Investigation

The next step was to perform instrumented tests on the road. The complete measurement system is diagrammed in Figure 1. Because of the nature of the problem, it was necessary to measure brake temperature, vibration, and interior noise simultaneously. Using the Link Model 2060 vehicle instrumentation system this measurement process was easily configured. Thermocouples were located on both rear brakes. Accelerometers and microphones were used to monitor rear brake noise and vibration. Finally, an interior microphone was used to quantify the interior cabin sound field.

The on-road testing showed that the brake pad temperature had to be above 350°F for the noise to occur. The predominant interior noise was found to be at 400 Hz with high levels of vibration seen in the brake components. The source of the

noise was clearly in the left rear corner area with possible participation by the braking system, powertrain, and suspension components.

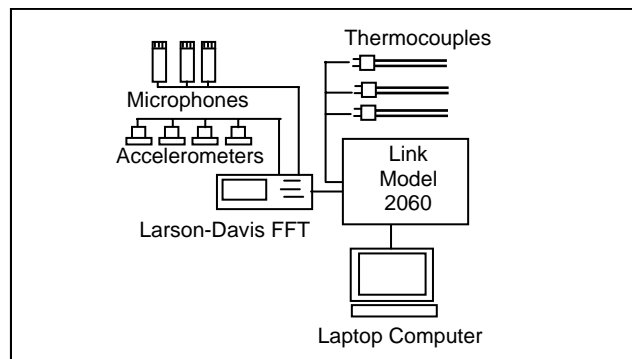


Figure 1 – Measurement System

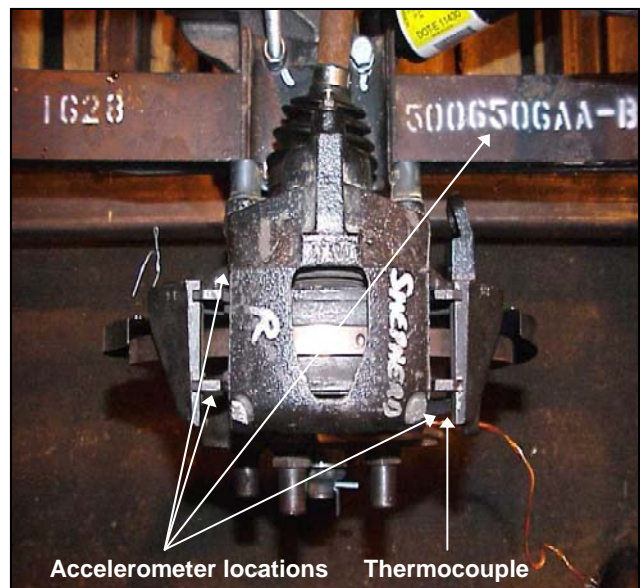


Figure 2 – Left Rear Caliper

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Noise Source Investigation

With agreement of the client, more focused tests were conducted to determine the root cause of the noise. Multiple acceleration measurements were made on specific brake components with correlation to the interior noise to identify the major contributors. Several of the measurement locations are illustrated in Figures 2 and 3. Table 1 describes the accelerations measured at the problem frequency of 400 Hz.

The anchor bracket front rail was the location of the major vibration amplitudes with energy at this frequency seen throughout the systems examined. The magnitude of the vibration on this anchor bracket is shown in Figure 4.

Examining the motion of the anchor bracket, it was evident that a cantilever like resonance was being excited along the caliper rail as shown in Figure 2. After consultation with the client, the next step was to find a way to minimize the vibration response and therefore, the noise.

Problem Resolution

It was decided that the best approach would be to add a tuned absorber to the brake rail to detune the resonance. Since the brake system was already in production, this was the preferred alternative because it involved a fix that could be applied to the existing system.

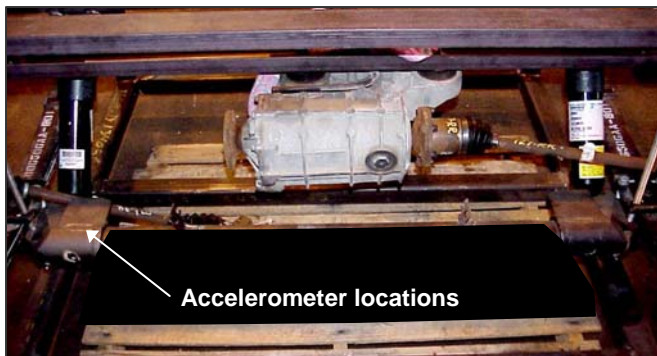


Figure 3 – Drivetrain and Suspension Components

Several alternative designs for the absorber were tested. Because of space and weight restrictions, it was difficult to arrive at an optimum solution. Collaborating with the client, a series of solutions were developed which reduced or eliminated the noise problem. One example was the use of a mass of only 460 grams placed on the left side trailing arm to reduce the noise level to the point where it was inaudible.

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Table 1 – Maximum Accelerations Measured at 400 Hz on Surfaces of Rear Powertrain and Braking Systems

Location	Acceleration, g's
Left rear inside pad	0.97
Left rear outside pad	1.19
Leaf spring	0.65
Knuckle	0.35
Left Rear Brake Caliper	1.89
Left Rear Front Anchor Bracket Rail	3.77
Left Rear Back Anchor Bracket Rail	2.84

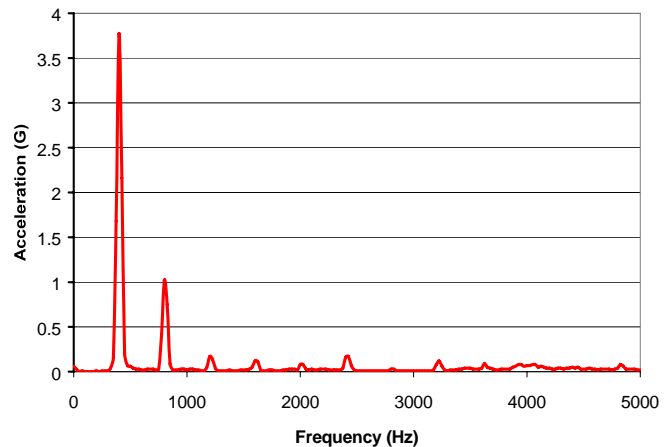


Figure 4 – Measured Acceleration at Left Rear Wheel on the Front Side of the Anchor Bracket

Please contact us to learn how we can help you with test system development and engineering services related to NVH.

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