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CASE STUDY

A NOVEL STRATEGY TO IMPROVE BRAKE PERFORMANCE WITH FRICTION VARIATION TECHNIQUES

A Case Study on Advanced Friction-Based Brake Pad Design for Noise Reduction and Enhanced Braking Stability

Author
Utsav Malankiya
Mechanical Engineer
Testek LLC
utsav@testek.com

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176, Gokul Nagar, Kanadia Road,
Indore, M.P., India, 452016

8819881288

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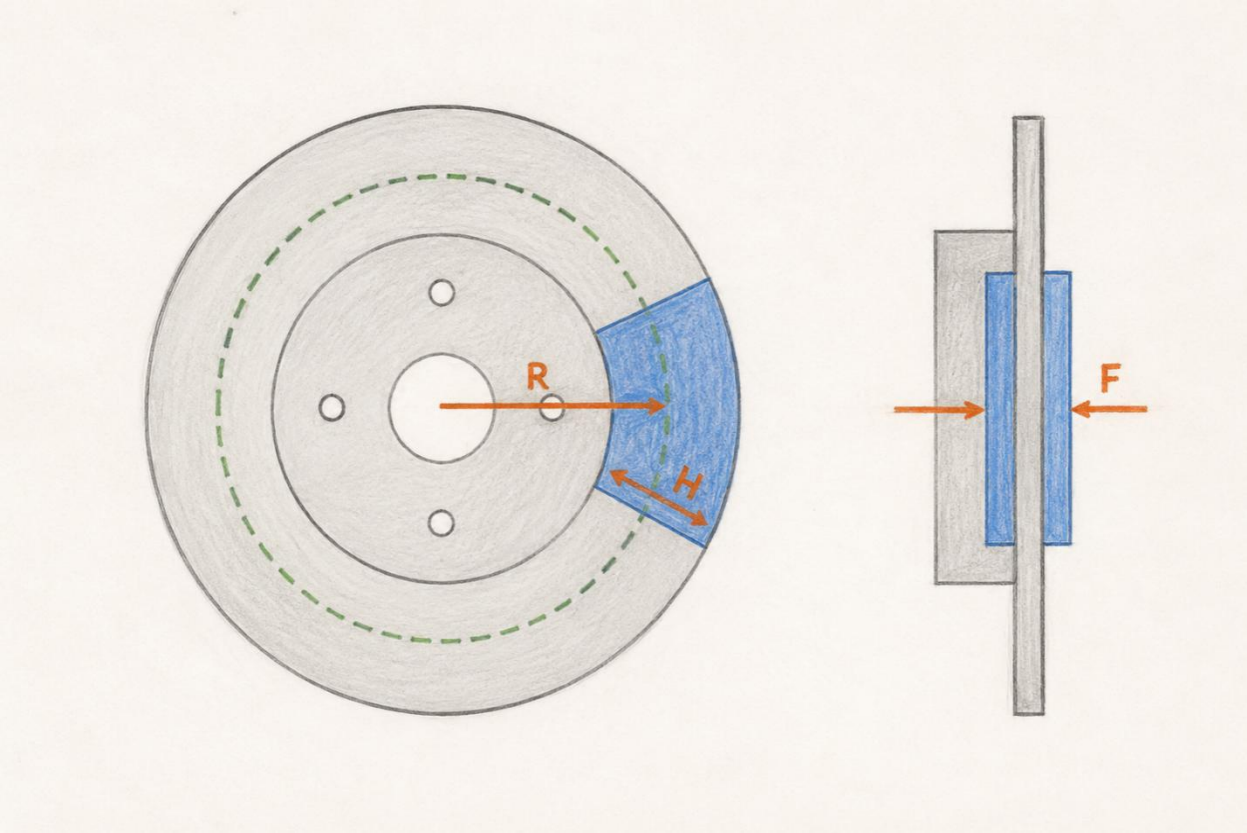

Figure 1: Brake Performance with Friction Variation Techniques

1. Overview

Brake squeal is one of the major noise problems that happens in the automotive industry. Even by incorporating the advanced brake technology along with stimulation tools, controlling the high-pitched noise without impacting the braking performance is still a difficult situation.

This case study focuses on bringing out the new brake pad design approach, which can significantly minimize the instability of the brake noise.

It focused on altering the coefficient of friction, which is abbreviated as COF, in the different areas of the brake speed rather than just focusing on the single or uniform friction material. The aim was to improve the braking performance and lower the noise generation that happened during braking.

2. Problem

During the time of braking, the friction between the brake disc and brake pad usually brought out the energy, which is generated in the form of heat, vibration, and even sometimes noise. In many cases these vibrations developed into brake squeal, which can minimize the overall refinement of the vehicle.

The company observed various issues that are associated with braking problems that incorporate

- Instability in the break noise
- Vibration behavior gets uneven.
- Squeal risk becomes increased.
- Noise-related friction concerns
- Reduced driving refinement

The research team looked for a better solution that could help them to develop a brake pad design that could effectively manage the friction force distribution without minimizing the effectiveness of the braking.

3. Challenges

The study identified that there were several technical challenges that are linked to the brake squeal behavior.

Some of the technical difficulties that were identified at the time of the analysis process incorporate

- Uneven slip rates, which happened across the brake pad.
- Different tangential speeds occur over the radius of the disc.
- Variation in managing friction
- Excessive generation of noise
- Braking power maintenance.

4. Solution

To improve the brakes' stability, the research team had introduced a new friction-based material arrangement that can have different coefficient friction zones all across the pad surface.

Figure 2: Innovative Brake Solutions

4.1 Variable brake pad design

Rather than utilizing the one friction material, the brake pad was divided into several radial sections, which have the different friction values.

Two main configurations were included, such as

- Three-section or partition brake pads
- Five partition friction layouts

4.2 Advanced brain stimulation pattern

The study utilized the advanced computer stimulation methods that can easily predict the instability of the brake and squeal behavior.

The engineering team performed the following aspects so that they could evaluate the instability strength

- Multiple pressure condition testing
- CEA-based instability analysis
- FEA brake stimulation
- Analysis for forward and reverse brake

4.3 Optimized friction pattern

Different friction layouts were analyzed to identify the best-performing design utilizing the methods such as

- Finite element analysis, which is (FEA)
- Complex Eigenvalue Analysis (CEA)

5. Outcome

The study analyzed that the changing friction coefficient distribution all across the brake pad can significantly reduce the brakes' stability performance in comparison to the traditional brake pads.

The most successful or best-performing design utilized

- Reduction in instability levels
- Improvised overall brake system stability
- Vibration strength gets lower.
- Damping performance gets better.
- Stronger noise control performance

6. Key Takeaways

The research demonstrates that the uneven friction behavior, which can be across the conventional brake pads, plays a significant role in brake noise as well as vibration control.

Key takeaway 1: Rather than relying on a single friction material, the research showcased that controlling friction variation carefully across the brake radius can significantly minimize the predicted brake noise levels.

Key takeaway 2: The finding suggested that the advanced friction material design is highly beneficial for automotive manufacturers. As it can improve the brake refinement as well as help in minimizing the noise-related issues without giving any impact on braking performance.

Author:
Utsav Malankiya
Mechanical Engineer
Testek LLC
utsav@testek.com

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176, Gokul Nagar, Kanadia Road, Indore, Madhya Pradesh, India
PIN: 452016
Landline: 07313145086
support@ijrtsm.com
ijrtsm@gmail.com
www.ijrtsm.com