What Causes Brake Squeal?

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The characteristic squealing sound during braking or when components are rubbing is caused by a rapid interaction between static and dynamic friction, known as the stick-slip effect.

Here's how it works in detail: The brake pad momentarily sticks to the rotating brake disc, no relative movement occurs even though force is being applied.

At this point, static friction is dominant. Once the applied force exceeds the maximum static friction, the connection breaks, and the pad begins to slide slightly, dynamic friction takes over.

However, this sliding phase doesn’t last long. Due to elastic restoring forces and the dynamic behavior of the system, static friction re-establishes almost immediately, and the cycle starts again.

This stick-slip process repeats several thousand times per second, typically at frequencies between 1,000 and 10,000 hertz. These rapid transitions generate mechanical vibrations, which are transmitted through the brake system (pads, calipers, disc) and surrounding components. The vibrating parts then radiate audible sound, resulting in the familiar squeal or high-pitched whine.

These vibrations are caused by the periodic "sticking and slipping" of the contact surfaces under load, a highly dynamic process influenced by material pairings, surface conditions, temperature, humidity, and the mechanical design of the braking system.

Best regards,

Jürgen Albert