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Brake System Service: Eliminating Noise and Vibration Problems

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Brake noise and vibration are two things few people will tolerate for very long ‹ especially owners of high-performance European sports cars and luxury sedans that are renowned for their eye-popping stopping power. People who spend upward of $30,000 or more for an upscale Asian or European nameplate usually expect their brakes to be quiet. That's why noise, vibration and harshness have received so much attention in recent years by the world's automakers.

Even in older cars and trucks, nobody wants to hear an annoying brake squeal or feel a shudder in the pedal when they step on the brakes. And they certainly don't want any noise or vibration after the brakes have been relined.

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ROOT CAUSE

The root cause of brake squeal is high-frequency vibration. When the brakes are applied and the pads contact the rotors, tiny surface irregularities in the rotors act like speed bumps, causing the pads to jump and skip as they scrape against the rotors. This, in turn, causes the pads to shake and vibrate in the calipers and against the caliper pistons. It also causes the calipers to shake and vibrate on their mounts and bushings. The greater the play between all of these parts, the greater the amplitude of the vibrations and the louder the squeal.

The rhythmic vibrations of the pads rubbing against the rotors also create harmonic vibrations in the rotors that cause them to ring like a cymbal. The areas generating the most noise can be seen with special laboratory equipment that uses a laser to scan the surface. Changes in color reveal the intensity and frequency of the vibrations. Researchers have found that rotor vibrations are not uniform all the way around a noisy rotor. The rotor has certain spots or "nodes" that oscillate more than other areas. By redesigning the casting and changing the location of the cooling fins between the rotor faces, some of this noise can be tuned out (a good reason to use replacement rotors that have the same cooling configuration as the original!).

Even the metallurgy of the rotors makes a difference. Some grades of cast iron are quieter than others. That's one of the reasons composite rotors have been used on various vehicles over the years. Besides being lighter, composite rotors can also be quieter if the right grade of cast iron is used for the rotor disc. Replacing a composite rotor with a solid, cast-iron rotor changes the harmonics and frequency of the brake system, which may increase brake noise on some applications.

Rotor finish also affects noise. The smoother and flatter the surface, the less the likelihood of the pads chattering and dancing as they ride across the surface. Rotors should be resurfaced at the proper speed and feed rate, and with sharp tool bits to achieve the smoothest possible finish. Light sanding with an abrasive disc or flexible honing brush after the rotors have been turned can improve the surface finish even more and provide an extra degree of assurance that the rotors will remain noise-free.

Worn brakes are usually noisy brakes. Play between the calipers and the mounts, missing or badly corroded shims, and/or missing, bent or broken anti-rattle clips and springs can all contribute to a noise problem.

Equally important are the pads themselves. Some friction materials are noisier than others, just as some brands of pads are quieter than others. Hard semi-metallic pads are naturally more noise prone than softer non-asbestos organic (NAO), low metallic or ceramic-based pads. The sound control qualities of any friction material depends on the fillers, lubricants and other ingredients that go into the mix. Some manufacturers add graphite and other materials to pads to dampen noise.

BMW released a technical service bulletin (34-03-00) that describes a squeal problem with the OEM "Textar" brake pads on 323i, 325i and 328i models. The cure, says BMW, is to replace the pads with quieter "Jurid 620" pads. All metal-to-metal contact points should also be cleaned and lubricated to further dampen vibrations.

The design of the pads also influences their noise characteristics. If the leading edge of the pads has a sharp edge, it increases the tendency to grab and bounce more than if the leading edge is chamfered. That's why most premium-grade aftermarket brake pads have chamfered edges. The pads may also have a slot down the middle to increase flexibility, cooling and venting.

Some friction suppliers use "Transfer Film Technology" (TFT) to prevent noise. TFT is not a coating on the pads but part of the friction material itself. As the pads wear, they continuously transfer a very thin film to the rotor surface. This film, which leaves a dull gray coating on the rotors, fills in tiny imperfections in the rotor surface to make it smoother and more compatible with the pads, thus eliminating squeal-producing vibrations.

Pads that use the transfer film technology also do not require shims behind the pads to dampen vibrations (unless required by the OEM caliper design).

This is because the coating prevents the pads from vibrating in the first place. And, unlike spray-on noise treatments that wear off the rotor surface, TFT lasts the life of the pads because it's in the pads and is constantly being reapplied every time the vehicle brakes.

STOPPING NOISE

So how do you fix noisy brakes and minimize brake noise following a brake job? You can start by examining the old brakes. Worn brakes are usually noisy brakes. Play

between the calipers and the mounts, missing or badly corroded shims, and/or missing, bent or broken anti-rattle clips and springs can all contribute to a noise problem. So too can rough or improperly refinished rotors and hard pads.

Shims are used in disc brakes as a dampening device between the pads and caliper and caliper pistons. Shims may be steel, with or without a soft facing material, or they may be nothing more than soft material applied to the backs of the pads. Either way, their job is to dampen vibrations at the source.

The trouble is, over time, shims deteriorate. Plain steel shims become badly corroded and may crumble into flakes after years of service. Stainless steel shims are the most durable and will last for years, but stainless is expensive. Many OEMs figure the pads will be replaced in a few years anyway so they use the less-durable, plain steel shims.

Some pads now have integrally molded, built-in shims. This eliminates the corrosion issue entirely, along with the chance of someone forgetting to install new shims when the pads are replaced. Just remember not to install regular shims with pads that have built-in shims, otherwise the pads may not fit the calipers.

Other mechanical devices that are often installed on original equipment brake systems include anti-rattle springs and clips. These may be attached to the caliper to help hold the pads in place, or attached between the pads.

If the factory-installed anti-rattle devices are missing, broken or bent, they obviously can't do their job. Unfortunately, many technicians overlook these parts or leave them off when replacing pads for two reasons: because they think the parts are not really necessary, or it's too much hassle to replace them if they are missing, broken or bent. Consequently, these technicians probably have a lot of comebacks because of noise.

One alternative to mechanical shims, clips and springs is to apply a brake noise compound to the backs of the pads before they are installed. Most of these products are a high-temperature RTV silicone-based material that forms a pliable and durable cushion on the backs of the pads. The material must be allowed to cure for 30 to 60 minutes before the pads are positioned in the rotors.

BRAKE LUBES

Another way to dampen noise-producing vibrations is to apply a high-temperature brake lubricant to the backs of the pads, and the points where the pads contact the caliper. Lubricating the caliper mounts, shims and bushings is also recommended to dampen vibrations. The lubricant also helps the parts slide smoothly so the pads wear evenly (uneven pad wear is a classic symptom of a floating caliper that is sticking and not centering itself over the rotor).

The key here is using the right kind of lubricant. The lubricant must be heat-resistant so it won't melt and run off the pads, and it must be durable so it will provide long-lasting protection. Synthetic lubricants that contain moly are a good choice for this type of application.

Never use ordinary chassis grease or silicone brake grease for this purpose.

Also, do not allow the lubricant to come into contact with the fronts of the pads or the rotor face. Keep it on the backs of the pads and the pad contact points.

SPRAY AWAY NOISE

The surface of a brake rotor, even with proper refinishing, can be a rough place at the microscopic level. What seems like a flat surface to the naked eye is actually a series of sharp peaks and valleys under a microscope. And as stated earlier, the rougher the finish, the more the vibration and noise when the brakes are applied.

One way to improve the surface on the rotors is to spray on an aerosol product that contains microfine aluminum particles. According to one manufacturer who makes a spray-on rotor treatment, the particles form a molecular bond with the rotor surface. This creates a "composite" surface that allows for a more controlled burnish as the new pads seat in. The result is less vibration and no annoying noise.

The same manufacturer also says its spray-on treatment increases brake torque up to 8 percent yet makes the brakes feel smoother ‹ so there are fewer comebacks.

Spray-on surface treatments obviously don't last forever, but they can help dampen noise for several hundred to several thousand miles, depending on how much the brakes are used. Pad manufacturers say rotor treatments should not be necessary as long as rotors are properly refinished, the pads are mounted securely, shimmed and there is no excessive wear or looseness in the calipers. Even so, those who use the spray-on treatments say it doesn't hurt anything and eliminates comebacks.

INSTALLATION TIPS
Rotor finish should meet or exceed OEM specifications. For most applications, that means a surface finish of 60 to 80 micro-inches or less.

A range of 20 to 50 micro-inches will usually guarantee quiet operation even on vehicles that are sensitive to brake noise.

Use the best tool bits you can afford to cut the rotors, and keep them sharp. Premium-quality, titanium nitride-coated carbide tool bits don't cost much more than standard carbide bits, do a better job of cutting through rust and typically last twice as long. Round bits may also give you a better finish than angled bits.

Composite rotors require special care when resurfacing because they lack the rigidity of cast rotors. The rotor needs to be supported by large bell caps or adapters, otherwise it may flex, leaving tool chatter marks on the surface. The other alternative is to use an on-car lathe to resurface composite rotors.

Honda, Nissan and several other import manufacturers recommend using an on-car lathe to resurface both the front and rear rotors on their vehicles. Honda says using an on-car lathe to cut the rotors reduces the risk of pedal pulsations because there is less runout with this method.

As for how deep and how fast to cut rotors, it all depends on their condition, size and the type of equipment you're using. One cut saves time and can achieve a nice finish on some lathes but not others. But if a rotor has a lot of runout in it or is deeply scored, several rough cuts may be necessary to true it before a final finish cut can be made.

If your lathe has a fixed spindle speed (100 to 150 rpm) but adjustable crossfeed, a single cut crossfeed rate of about 0.003 in. to 0.005 in. per revolution should give good results. If the rotor needs two or more cuts, the depth of the first cut can be as much as 0.010 in. at a crossfeed rate of up to 0.010 in. But the final cut should be limited to 0.002- to 0.004-in. in depth at a feed rate of no more than 0.002 in. per revolution. On lathes with adjustable spindle speeds, the spindle speed should be slowed down for

larger rotors. One manufacturer suggested the following speeds: for 10-in. and smaller rotors, use 170 rpm; for 11- to 16-in. rotors, use 100 rpm; for 17-in. or larger rotors, use 60 rpm.

After rotors have been turned, they should be washed with soap and water and allowed to air dry before they go back on the vehicle. Many technicians skip this step, not realizing how dirty the rotor surfaces are after they've been turned. Microscopic particles on the surface can become embedded in the new pads, possibly causing pads that would otherwise be quiet to squeal in protest.

Test-drive the vehicle after the job has been completed to verify there is no noise. If the pads are the uncured variety, make 10 to 15 normal stops from about 30 mph, allowing at least 30 seconds between stops for the brakes to cool. The customer should then be advised to avoid heavy braking or panic stops for the next 200 miles.

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