BRAKE NOISE DIAGNOSIS

Brake noise, arguably the most common of all customer complaints, is also one of the most troublesome to cure for both the brake engineer and service technician alike.

Many hours of intensive design and testing work goes into minimising the amount of noise a system produces, even though noise has no affect on braking performance.

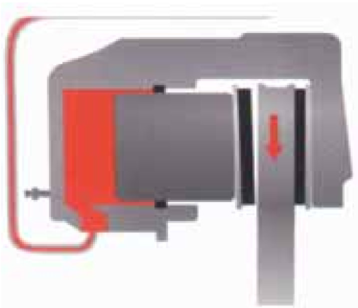
In fact a squealing brake is not an indication that the brake is working inefficiently, however, customer perceptions are different and hence the large effort that is put into eliminating noise.

The best cure for brake noise is to prevent it occurring in the first place and the best way to do this is by correct servicing and installation using genuine replacement parts.

But before we examine these procedures, let us first look at the various types of noises encountered and some of their most common causes.

Squeal and squeak would have to be the most common types of noises that the service technician has to deal with.

These noises are caused by high frequency vibrations when two or more components in the braking system reach the same natural frequency. When this occurs, we hear it as break squeal or squeak.

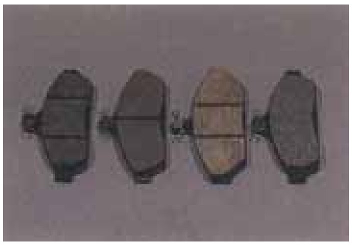


Whilst squeal and squeak are usually associated with disc brakes, drum brakes can also be prone to squealing, the only difference being in the components involved in producing the noise.

These noises or vibrations can occur during braking from virtually any speed and at any stopping rate and is the reason why a number of measures are incorporated in the original design and installation to minimise them.

Groan or graunch is a noise that is usually encountered just as the vehicle is coming to rest from a low speed and is caused by a momentary change in the lining materials frictional characteristics.

The type of lining material used has a great bearing on whether or not this noise will be encountered, some material being more susceptible than others.



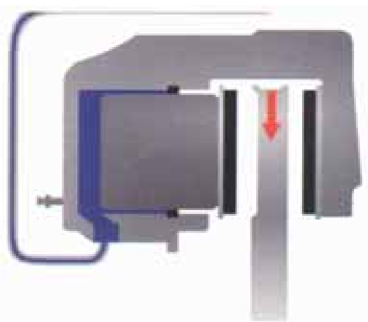
Weather conditions can also contribute to this problem. Vehicles which are parked outside, especially in wet or high humidity areas, may suffer from a condition known as "morning sharpness".

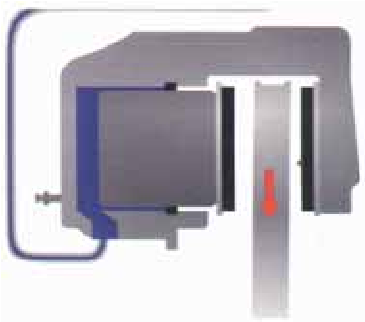
BRAKE NOISE DIAGNOSIS

This condition is due to the lining material absorbing moisture during the cool-down period. This in turn causes the brakes to feel overly sensitive and prone to grabbing during the first few application so when the vehicle is driven after having been left standing for some time.

Along with this sensitivity comes groan and graunch, however, this is usually only a transient condition which goes away once the lining material has reached its operating temperature.

Judder is a wheel frequency vibration that is felt through the brake pedal, steering wheel and body of the vehicle itself. The most common causes of judder in disc brakes is rotor thickness vibration and run-out.



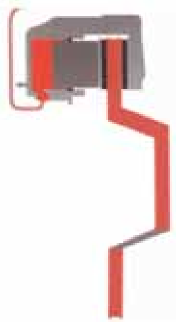


Rotor thickness variation can be generated by insufficient pad retraction or binding sliding calipers. This allows one pad to stay in contact with the rotor in the released position, causing the rotor to wear unevenly.

Rotor run-out on the other hand may be caused by uneven tightening of the rotor retaining bolts or wheel studs being unevenly tightened and over torqued by impact tools.

It can also occur when the brakes are used repeatedly, with little cooling down time between applications.

In these circumstances temperatures are elevated considerably above normal and, should the casting of the rotor not be of uniform thickness all over, uneven cooling of the rotor will result.



This uneven cooling causes the rotor to distort, which means it then has run-out and eventually judder.

Not surprisingly ventilated rotors are more prone to developing run-out than solid ones, there being more chance of casting thickness variations with the ventilated design.

In drum brake systems judder is usually caused by the drums wearing oval, possibly due to repeated heavy braking or the handbrake being firmly applied when the brakes are extremely hot.

BRAKE NOISE DIAGNOSIS

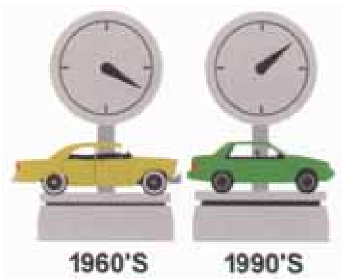
Applying the handbrake causes that portion of the drum where the shoes contact to cool at a different rate, leading to distortion and judder.

Yet another cause is hot spots in the drums. These are usually caused by a combination of heavy braking and lining materials which have high spots. These high spots cause uneven heat generation and rapid temperature rise which in turn leads to hot spotting.

The final noise we shall look at is hum. Hum is usually associated with rear disc calipers and only occurs at low speeds, often when reversing.

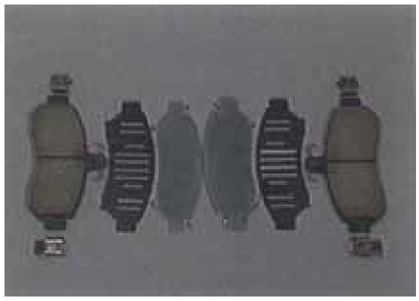
The usual cause is calipers that fail to release properly, leaving one or both pads partially applied.

Over the years, vehicle manufacturers have continually striven to reduce the weight of motor vehicles as a means of increasing performance and economy. Since brake noise is greatly affected by component rigidity, the challenge for the brake engineer has been to reduce component weight without sacrificing strength or performance.



Whilst these criteria may be at odds with each other, the challenge has been successfully met with braking system performance increasing all the time.

It has also meant careful attention to design detail and the addition of some brake hardware to reduce the noise levels which are always present in any braking system.



Early fixed head calipers used a step on the piston face as an anti-squeal mechanism, making correct alignment in accordance with manufacturers' recommendations of vital importance.

This was then supplemented with the use of steel shims between the pistons and pad backing plate as an additional means of dampening the high frequency vibrations.

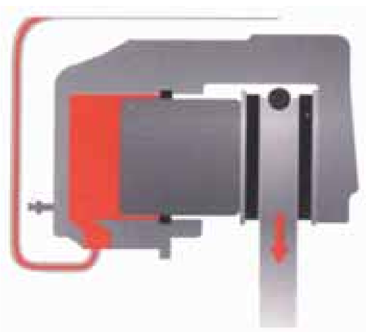
These shims are usually marked in some way to facilitate correct assembly and may also require the use of some form of lubricant in order to increase their effectiveness.

In some instances the lining material itself is offset to the piston centre line, making correct installation of the utmost importance.

The early systems also used solid rotors which are more prone to noise than the more modern ventilated designs.

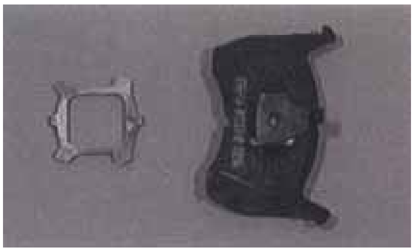
To help overcome this, a groove was turned in the outer edge of some discs to which was fitted either a welded ring or a wound on wire.

The idea behind this was to provide increased damping so that when the disc started to vibrate at its natural frequency, the energy would be used up in producing movement between the disc and the wire ring rather than in producing noise.



Modern disc brake pads have anti-squeal material bonded to their backing plates but may also employ an additional steel shim on the piston side pad.

Others go further still, using special shim packs coated with lubricant and clipped to the pad braking plate.



Finally, pad end flutter makes a significant contribution to brake noise, hence the use of clips which fit between the backing plate ends and caliper bracket on some systems. Removal or incorrect assembly of any of these shims or clips can lead to unacceptably high levels of noise.

With drum brakes we find that it is the shoe design that plays a major role in minimising the amount of noise produced.

A brake shoe must have a certain amount of flexibility which will allow it to conform to the shape of the drum during braking. Making the shoe flex ensures even contact over the whole shoe and not only reduces noise but also increases braking force.

To achieve this, brake engineers spend many hours in design and testing to arrive at the correct profile of the shoe web.

In some cases specially shaped slots are even cut into the web itself to achieve the correct degree of flexibility.

Also of significance in the reduction of noise is the way the shoes are located against the backing plate. Brake shoes are commonly held firmly against their backing plates by some form of spring or clip and anchored at their ends by wheel cylinders or anchor points.

It's worth noting here that even with these clips and anchors to reduce shoe vibrations, most manufacturers recommend that some form of high viscosity lubricant, such as caliper slide grease, be applied to the shoe ends and where they contact the backing plate.

Having now looked at the various type of brake noise and some of the design variations used to minimise them, we shall now go through the correct procedure for fitting a set of new disc pads and brake shoes.

Because the new pads will be thicker than the old worn ones, the pistons in the calipers will have to be pushed back into their bores to allow the calipers to be refitted.

This will displace fluid back into the master cylinder reservoir. To prevent it from overflowing, the fluid level in the reservoir should be first lowered by approximately two thirds of its capacity.

The vehicle can then be raised and the wheels removed. Once this has been done, the first step in any reline process is an examination of the brake system components. We shall start with the disc rotor

Rotors should be checked for run-out using a dial indicator and thickness variation, preferably using a micrometer for accuracy. In the absence of these, a reasonably accurate check can be made by rotating the disc by hand with the caliper and pad still in place.

If the rotor drags appreciably in one place as it rotates, it can be assumed that some amount of run-out or thickness variation exists.

In addition to this, a smooth rotor surface is essential for correct bedding in of new lining material and the prevention of noise.

It should be noted however, that smooth does not mean glazed. A highly polished surface that readily reflects light will not allow modern lining materials to bed in correctly and is especially true for semi-metallic linings.

Should any of these conditions exist, the rotor, providing it is not below its minimum thickness, will require machining.

Rotors which have been machined to or past their maximum limit will have to be replaced.

BRAKE NOISE DIAGNOSIS

A point worth mentioning here is that after the caliper is removed, it should be suspended from a piece of wire attached to some part of the suspension or body. This prevents the dangerous situation of the brake hose having to take the weight of the caliper.

Rotors should always be machined in two stages. The first stage is used to remove all surface irregularities and is done in even cuts from both sides of the rotor to a depth of between 0.125mm and 0.25mm.

Tool feed speed should be 0.15mm to 0.25mm per revolution.

The final cut is done to a depth of approximately 0.1mm on both sides of the rotor.

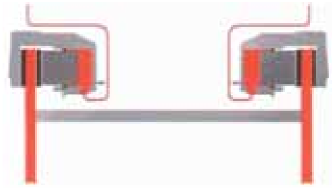
Tool feed speed being 0.05mm per revolution. This slow speed is necessary to give an acceptable surface finish to the rotor.

To finish off, 120 grit emery paper is used to remove any traces of graphite brought to the surface by the machining process which could contaminate the surface of a new pad.

Also by moving the emery with a circular motion a non-directional swirl pattern, necessary for today's semi-metallic and non-asbestos lining materials can be achieved.

The last important point about disc rotor machining that is often overlooked is the final disc thickness.

Disc rotors should be the same thickness on both wheels of an axle. This ensures that both rotors heat up at the same rate, maintaining stable braking performance as the temperatures rise.



Also remember, whether the disc has been removed for machining or not, the wheel bearings must be adjusted in accordance with manufacturers' recommendations.

We can now turn our attention to the brake calipers. If they are the type where the brake pads are held into them by clips, the pads should also be removed at this point.

Following this, the pistons should be pushed back into their bores. These pistons must slide easily into their bores and, should any difficulty be experienced, both calipers must be overhauled to ensure that the pistons will retract properly.

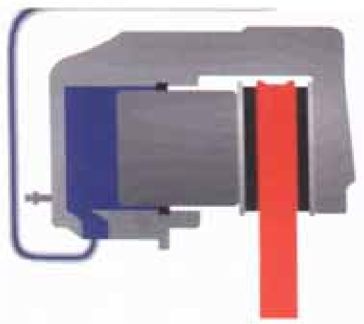
Once the pistons are pushed back, the caliper assemblies can

BRAKE NOISE DIAGNOSIS

then be checked for serviceability. The first points to check are the slides. You should be able to move them their full distance using only light finger pressure.

Slides that are tight or seized prevent the pads from being pulled completely away from the disc.

This leads to the pad overheating, excessive disc wear and thickness variation problems, brake fade, fluid vaporisation and increased fuel consumption.



Due to the importance of the slides being able to move freely, Wingate recommends that they be removed completely, cleaned and re-lubricated using special caliper slide grease each time the brake pads are replaced.

Also, if any of the rubber boots which prevent water and dust entry are torn or damaged, they should be replaced at this point.

Following this, the piston dust boot should be inspected for tears and brittleness.

Torn Boots or brittle ones that are likely to tear soon, allow water and dirt to enter. This in turn allows corrosion to form between the piston and caliper body, requiring higher pressure to move it and preventing it from retracting properly.

As the corrosion continues to build it gets to a point where the piston finally seizes completely and the brake no longer works.

If any of these problems are present, both calipers from the axle should be overhauled. Once the inspection or overhaul has been completed the new pads can now be fitted.

Care should of course be exercised in ensuring all noise suppression shims and clips are reinstated.

Whilst some manufacturers place the shims on the back of the pads dry, others recommend that 80% of the shim surfaces be coated with caliper grease.

Another common recommendation by some manufacturers is the use of caliper cement. This is usually employed in systems that do not use shims.

All these methods are aimed at increasing the amount of damping in the system and because of the number of different methods employed, manufacturers procedures should always be followed.

In addition to this, the places where the pads rest in the caliper support should be coated with a small amount of caliper slide grease to also help dampen pad vibrations.

The caliper can now be replaced, making sure that any anti-rattlesprings or clips are positioned correctly on those systems that have them fitted.

Caliper and anchor mounting bolts should always have their threads cleaned and a small amount of thread locking compound applied to them before being replaced and torqued to manufacturers' specifications.

In some cases manufacturers require that these bolts be replaced each time they are removed. In this case, new bolts are included with genuine replacement pads and their threads already coated with a locking compound.

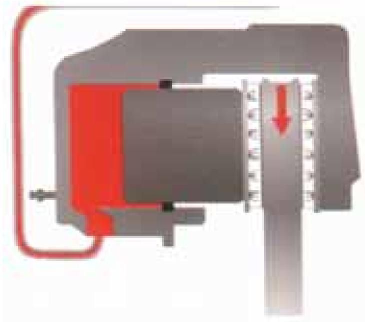
The wheels can now be replaced and should be tightened evenly in an alternate pattern to the manufactures recommended torque. This ensures that the disc rotor will not be distorted, causing disc run-out and judder.

Once the wheels are replaced the brake pedal should be slowly pumped approximately half way to bring the pads into contact with the disc rotors.

We've now reached the point where we can road test the vehicle and bed the pads in but before we do, the master cylinder should be topped up with the correct grade of brake fluid.

Wingate does however recommend that when replacing brake linings the fluid should also be replaced.

Bedding pads, or burnishing them to give the process its correct name, is done to bring the resins in the pad to the surface, giving it the correct frictional properties and preventing premature wear. The golden rules when bedding in pads are don't get them excessively hot and don't drive with your foot resting on the pedal.



The correct procedure is to accelerate the vehicle to sixty kilometres per hour and then using moderate pressure, slow it to ten kilometres per hour. The vehicle is then accelerated again back to sixty kilometres per hour and the process is repeated ten to fifteen times, leaving half a kilometre between brake applications to allow temperatures to stabilise.

Now here's a few tips on the process. Firstly, unburnished pads take longer to slow or bring a vehicle to rest, so don't tail-gate other vehicles.

Secondly, try not to sop the vehicle during the process as this may put excessive heat into the pads.

Thirdly, when finished let the car stand for some time to cool the pads before returning it to the customer. This will prevent them from overheating and damaging the pads.

And finally a word on brake pads.

Brake engineers spend many hours of testing to arrive at a compound that will suit the vehicle under a variety of driving conditions. Take advantage of all their hard work and use the pads that are recommended by the manufacturer.

Having covered disc brakes, we will now turn our attention to drum brake relining.

As with the disc brake rotor, drum surface condition is of the utmost importance when it comes to bedding in a new lining material.

Surface smoothness, run-out and glazing being just as important for correct drum brake operation as it is for the disc brake.

This means that in the majority of cases the drums will need machining each time the brakes are relined.

As the machining procedures are basically the same from drums as discs, we won't go over them again except to stress the importance of two main points.

The first is that drums have a maximum diameter that they can be machined to and the figure is usually cast into the drum.

Drums need to be checked for size before and after machining. They should also be the same diameter on both wheels of an axle and if oversized replace in pairs.

The second is that cleaning the freshly machined surface with 120 grit emery after the final cut has been made is vital to remove any of the graphite which may have come to the surface during the machining process.

The new brake shoes should then be ground to the radius of the drums. This highlights another reason for ensuring that the drums on an axle are the same diameter because it allows all the shoes to be ground to the one radius, eliminating the risk of mix-up during assembly.

Following the machining of the drums and shoes, the backing plates should be thoroughly cleaned and the shoe support nibs lubricated with caliper slide grease.

It must be stressed that this is only a light coating. Too thick a coating could melt and contaminate the lining material under high temperature conditions. Before commencing assembly, handbrake and shoe adjusting mechanisms should be cleaned but not lubricated.

The reason for this is that the lubricant tends to trap the road grime and brake dust which in turn seizes the adjuster preventing it from operation. The adjusters can then be backed completely off prior to assembly.

This will ensure that correct handbrake and brake shoe geometry is maintained when the shoes are adjusted after the reline is completed.

Brake shoe retraction springs and hold down clips should be examined for signs of stretching, nicking or distortion.

Should any of these be present, the springs or clips should be replaced in sets for both wheels on the axle.

The brakes can now be re-assembled with a small amount of caliper slide grease applied to the shoe ends.

Once assembly has been completed the brake shoes and handbrake can then be adjusted.

When adjusting drum brakes, the handbrake should always be backed off and the shoes adjusted first.

This ensures that when the handbrake is adjusted, the apply lever is back against its stop in the released position.

Then, when the handbrake is applied, the maximum amount of force is applied to the shoes by having the angle formed between the lever and cable as close to ninety degrees as possible.

On systems with adjusting apertures the shoes should be adjusted until the wheel locks solid and then backed off until a light rub can be heard when the wheel is spun by hand.

This of course means that any self adjusting mechanism will have to be held away from the adjuster whilst being backed off.

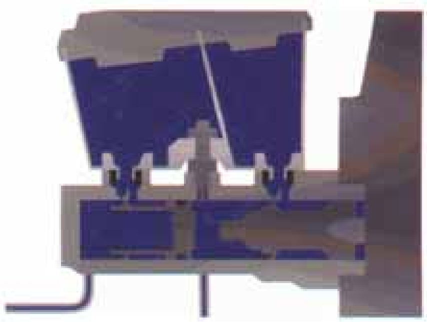
A piece of welding wire can be bent to do this and a useful tip is to bend up the wire and leave it in place before putting the drum back on.

If, on the other hand, no provision is made in the backing plate for adjustment, the shoes will have to be adjusted so that whilst the drum can still be easily replaced, a light rubbing noise is heard when it is rotated.

Failure to do this may mean that the brake will never adjust owing to the fact that the master cylinder may not displace enough fluid for the self adjusters to work.

BRAKE NOISE DIAGNOSIS

Or in the case of an old master cylinder, the cylinder bore may be damaged by dirt picked up when it travels further than it normally does.



Our last adjustment is the handbrake and once correctly adjusted, should not need adjusting again until the next reline.

Whilst this may sound an unusual statement, remember that the clearance between the shoes and the drum is controlled by the shoe adjuster and not the handbrake lever.

The simplest way to adjust a handbrake is done with the wheel on but clear of the ground.

The handbrake is first applied two clicks on its ratchet and the cable is then adjusted until a slight increase in the effort to turn the wheels is felt.

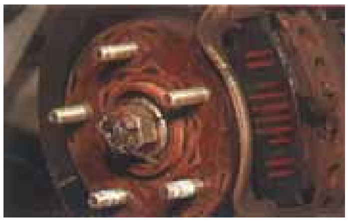
The adjuster can now be locked up and the adjustment is complete.

All that is required now is the road test and initial bedding in procedure.

The same procedure that was used for disc brakes can be used for drums and remember, don't get them too hot or the lining material will be damaged.

Now one final word about the relining process. New linings are more compressible than properly bedded in linings. This means that initially the brake pedal may feel slightly spongy for the first week or so of operation. This is prefectly normal and the pedal should return to normal after then. Remember to tell your customer this to prevent any misunderstandings.

Also, whilst we have shown the fitting of new linings, the procedures shown can also be applied to linings that are already in service but not near minimum thickness.



By following the procedures covered in this video, brake noise in both drum and disc brakes can be kept to a minimum.