



Brake Tech #03

Disc Distortion or 'warping'

Are warped brake discs the main cause of brake judder?

Absolutely not! The overwhelming majority of brake judder complaints are caused by a condition called Disc Thickness Variation (DTV). In fact brake discs actually warp or distort rather seldom. However distortion can occur and it is worthwhile understanding the causes of distorted brake discs.

[IMPORTANT: If you have not read Brake Tech article #1, entitled [The final word on brake judder](#) then please do so BEFORE reading this article.]

Let's start off with a basic definition for a "warped" (hereafter referred to as "distorted") brake disc.

A brake disc is considered distorted if, during operation or as a result of operation, it changes shape leading to unacceptable axial runout of the friction surfaces of the disc in relation to the caliper and brake pads.

This condition may or may not be felt as a brake judder of varying levels of intensity.

In other words we are ruling out discs that have unacceptable runout measurements, prior to operation, when they leave the factory. Runout that results from poor manufacturing processes will lead to DTV and brake judder but did not result from use/abuse of the disc and can therefore not be considered a result of disc distortion.

Permanent distortion

A disc is considered to have permanent distortion when the change in shape and resulting runout remain after the disc has returned to ambient temperature (cooled completely). In other words it is a permanent condition and will normally be felt even on the initial brake application when disc are cool and is referred to as – "Cold Judder".

In our experience the most common cause of disc distortion is the failure of drivers to 'season' or stress-relieve new discs by following recommended bed-in procedures. During the disc casting process molten iron is poured into sand moulds at temperatures in excess of 1350°C and allowed to cool rapidly into solid form. This rapid cooling causes internal stresses to be 'stored' within the disc casting. Gradual and moderate thermal cycling (as experienced when bedding-in discs properly after fitment) is a very effective method of relieving these stresses. On the other hand - sudden, dramatic heating and cooling of un-seasoned discs can lead to distortion or cracking.

So, the message is clear. Always bed discs in correctly prior to hard driving. This will relieve internal stresses within the disc and ensure maximum resistance to distortion. (To read more about the correct bedding-in of new discs click here. Powerbrake™ discs ALL undergo a series of 'weathering' processes during manufacture that are designed to stress relieve the disc castings. Extensive testing has shown that these

processes substantially reduce the chances of distortion and cracking. Having said that, we are the first to point out that correct bed-in has numerous other advantages and **MUST** be completed before any hard driving is attempted.

Temporary distortion

A disc can also exhibit temporary distortion that occurs when the disc changes shape during operation, resulting in temporary runout, which then disappears after the disc has returned to ambient temperature (cooled completely). In other words it is a temporary condition and will normally be felt only while braking when discs are running hot. It is therefore referred to as "**Hot Judder**".

Hot judder seems to be most prevalent in discs that have a wide (or tall) friction surface (or pad track). It is believed that the differences in heating rates (and the resulting expansion rates) that are caused by substantial differences in rubbing speeds experienced at the inside and outside diameters of the disc friction surfaces can lead to a condition of operational distortion or "Hot judder". This cause seems to be particularly prevalent on many German luxury sedans that feature discs with wide pad tracks and tall pad profile's. The solution often lies in the choice of pad compound that is used in these applications. We recommend staying with a premium quality semi-metallic pad. The high metal content of the friction material tends to pull a lot of heat out of the disc, hereby lowering disc temperatures and limiting the causes of "Hot judder". Hi-friction aramid-fibre pads with low metal content will put far more heat into the discs, making the situation worse.

Another common cause of temporary distortion is uneven material thickness of the friction surfaces of the disc. This occurs as a result of core shift during the casting process. In other words, while the outer surfaces of the disc run true from the factory, they end up expanding at different rates during operation as a result of the different thickness of the disc at different points. This results in temporary distortion of the disc when hot or "Hot judder". The cooling vanes of the disc make it impossible to correct the thickness variances through machining and the disc must be replaced.

Finally, you should never leave the brake pedal of a vehicle applied after bring the vehicle to a standstill when the discs are very hot. The area in contact with the friction material will not be allowed to cool as quickly as the rest of the disc surface resulting in definite temporary and possible permanent distortion. This is particularly relevant to drivers taking part in track days. You will often notice that race teams will push a racecar backwards and forwards in the pits for a few minutes after the vehicle comes off the track. This is to allow the discs (and other components) to rotate and cool more evenly.

Distortion leads to DTV

The most important point to accept is that disc distortion, whether temporary or permanent, will eventually lead to DTV. DTV is THE main cause of severe brake judder and results in a downward spiral that will damage a brake disc beyond repair.

Tips for avoiding disc distortion:

- Buy premium quality discs that are measured in all critical dimensions prior to shipping.
- Buy discs that are 'weathered' or 'seasoned' by the manufacturer.
- Always follow the manufacturer's bed-in instructions before driving hard.
- Be careful of low-metallic, high-friction pads on applications using wide pad track discs.
- Slow down and let your discs cool before parking the vehicle.

- Drivers taking part in track days must do a cool down lap prior to leaving the track.
- Never wash your car or spray cool water onto your discs when they are hot.

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