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Influence Of Various Parameters For Reliable Analysis Of Disc Brake Rotor

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***Abstract*—In the present work various parametersof rotor has been discussed for reliability of disc brake.Brake drum used in past design has been replaced by disc brakes which find application in motor bikes, racing bicycles,cars.It is having advantages of compactness,strength,water spillage out side the brake surface and heat dissipation by ventilation. The metallurgical properties of a rotor determine its strength, noise, wear and braking characteristics.Proper composition of the rotor is carefully selected and controlled during the casting. The rate of cooling also affects the hardness of a rotor. If a rotor is too hard, it will increase pad wear and noise.In this paper rotor metallurgy,cooling ribs,heat dam,surface finish have been explored for the reliability**

Index terms—Brake; metallurgy; cooling ribs; heat dam; surface finish

I. INTRODUCTION

The disc brake is a device for slowing or stopping the rotation of a wheel while is in motion. A brake disc is usually made of cast iron, but may in some cases be made of composites such as reinforced carbon-carbon or ceramic-matrix composites. This is connected to the wheel and/or the axle. To stop the wheel, friction material in the form of brake pads (mounted on a device called a brake caliper) is forced mechanically,
hydraulically, pneumatically or electromagnetically against both sides of the disc. Friction causes the disc and attached wheel to slow or stop. Joe Y.G. cha [1] explained Analysis of disc brake instability due to friction induced vibration.M.Bayat[2] explained the effect of ceramic in combination of functionally graded rotating disc and the friction-induced vibration with a constant friction coefficient. Utz von wagner[3] explained Influence of dynamic brake pad properties on automotive disc brake squeal. Brakes both disc and drum convert friction to heat, but if the brakes get too hot, they will become less effective because they cannot dissipate enough heat. This condition of failure is known as brake fade. The energy absorbed by brakes is dissipated in the form of heat.This heat is dissipated in the surrounding atmosphere to stop the vehicle.

II. DISC BRAKE ROTOR

The underlying scientific principle here is that friction converts motion into heat. The amount of heat that is generated depends on the speed and weight of the vehicle, and how hard the brakes are applied. The rotor's job is to provide a friction surface, and to absorb and dissipate heat. Big rotors can obviously handle more heat than small rotors. But many cars today have downsized rotors to reduce weight. Consequently, the brakes run hotter and require better rotor cooling to keep brake temperatures within safe limit. Uneven rotor wear (whichmay be due to excessive rotor runout or rotor distortion) often produces variations in thickness that can be felt as pedal pulsations when the brakes are applied. The condition usually worsens as the rotors continue to wear, eventually requiring the rotors to be resurfaced or replaced. Rotors can also develop hard spots that contribute to pedal pulsations and variations in thickness. Hard spots may be the result of poor quality castings or from excessive heat that causes changes in the metallurgy of the rotors. A sticky caliper or dragging brake may make the rotor run hot and increase the risk of hard spots forming. Hard spots can often be seen as discolored patches on the face of the rotor. Resurfacing the rotor is only a temporary fix because the hard spot usually extends well below the surface and usually returns as a pedal pulsation within a few thousand miles. That is why most brake experts replace rotors that have developed hard spots.

Cracks are another concern with rotors. Cracks can form as a result of poor metallurgy in the rotor (too hard and too brittle because the rotor was allowed to cool too quickly during the casting process), and from excessive heat. Some minor surface cracking is tolerable and can often be removed by resurfacing, but large cracks or deep cracks weaken the rotor and increase the risk of catastrophic failure. So cracked rotors should always be replaced.

III. ROTOR METALLURGY

The metallurgical properties of a rotor determine its strength, noise, wear and braking characteristics. The casting process must be carefully controlled to produce a high quality rotor. You cannot just dump molten iron into a mold and hope for the best. The rate at which the iron cools in the mold must be closely monitored to achieve the correct tensile strength, hardness and microstructure. When iron cools, the carbon atoms that are mixed in with it form small flakes of graphite which help dampen and quiet noise. If the iron cools too quickly, the particles of graphite do not have as much time to form and are much smaller in size, which makes for a noisy rotor. The rate of cooling also affects the hardness of a rotor. If a rotor is too hard, it will increase pad wear and noise. Hard rotors are also more likely to crack from thermal stress. If a rotor is too soft, it will wear too quickly and may wear unevenly increasing the risk of pedal pulsation and runout problems. The composition of the iron must also be closely controlled during the casting process to keep out impurities that may form "inclusions" and hard spots. One rotor manufacturer says they sample the molten iron every 15 seconds to make sure the composition is correct. The molten metal is also poured through ceramic filters that trap contaminants. Even the sand that is used to make the molds is specially treated to control moisture content. This helps keep the sand in place and prevents core shifts that can affect porosity, dimensional accuracy and balance. The grade of cast iron that is used in a rotor may even be changed to suit a particular application. One aftermarket rotor manufacturer uses a special grade of "dampened iron" to make replacement rotors for 1997-2002 Chevrolet Malibu and its sister vehicles (Olds Alero, Olds Cutlass and Pontiac Grand Am). In this case, the original OEM rotors turned out to be too noisy so General Motors switched to a dampened grade of iron to cure the problem.

IV. ROTOR COOLING RIBS

Vehicle manufacturers use a wide variety of different cooling rib configurations in their rotors. They do this to optimize cooling for different vehicle applications. So even though the brakes may appear to be identical on two different models, one may require increased cooling because the vehicle is heavier, has a more powerful engine, has less airflow around the brakes. Some aftermarket rotor manufacturers use the same rib design and configuration as the OEM rotors, while others do not. Some change the rib design to simplify the casting process or to reduce the number of different rotor SKUs in their product lines.

The OEMs currently use almost 70 different rib configurations in their rotors. Some ribs are straight, some are curved and some are even segmented. Some rotors are directional and some are not. Some rotors have evenly spaced ribs while others do not. Some ribs radiate outward from the center and others go every which way. One reason why they use so many different rib patterns is to maximize cooling and to reduce harmonics that contribute to brake squeal. Changing the rib design changes the airflow, cooling and noise characteristics of the rotor, which may make things better or worse depending on the application. That is why some aftermarket rotor manufacturers use the same basic design as the original, while others stick with more traditional venting. One brake manufacturer showed us a cutaway of an offshore "economy" rotor for a particular vehicle that had 32 ribs. The OEM rotor, by comparison, had 37 ribs and provided up to eight percent better cooling than the economy rotor when tested in the laboratory. And because the OEM rib design ran cooler, pad life was 28 percent longer than the economy rotor.

Another aftermarket brake manufacturer showed us test results that proved their rib design improves cooling and makes their rotor three times quieter than a competitive rotor. The recorded sound levels showed noise as high as 85 decibels screaming out of the Brand X economy rotor compared to only 40 to 50 decibels from their own "premium" quality rotor.

V. ROTOR HEAT DAM

A heat dam is often machined into the area between the friction surface and hat on most rotors. The dam is a thinner section of metal that reduces heat transfer from the rotor surface to the hat. This protects the wheel hub and bearings from the heat and also allows the rotor to flex when it gets hot to reduce the risk of warping and cracking. If a rotor manufacturer cuts corners and eliminates the heat dam, heat can travel more easily to the hub and wheel bearings and increase the risk of bearing failure. The rotor may also be more prone to cracking under high heat conditions.

VI. ROTOR SURFACE FINISH

Smoother is always better because it affects the coefficient of friction, noise, pad seating, pad break-in and wear. As a rule, most new OEM and quality aftermarket rotors have a finish somewhere between 30 and 60 inches RA (roughness average) with many falling in the 40 to 50 RA range. New rotors should always be installed "as is", and indexed on the vehicle with a dial indicator to minimize runout. As a general rule, there should be no more than .003 inches of rotor runout on most cars and trucks, but some cars cannot tolerate any more than .0015 inches of run out. Few technicians take the time to do this, but if they did they had probably see fewer comebacks because of pedal pulsation complaints.

VII. ADVANTAGES OF DISC BRAKE OVER DRUM BRAKE

Disc brakes are generally considered superior to drum brakes as they dissipate heat better due to brakes work by converting motion energy to heat energy.

VIII. CONCLUSIONS

These are the factors which influence the work of disc brake. Therefore the careful selection of the parameters is essential for improving the life and reliability of brake disc.

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