

Modelling and Analysis of Disc Brake

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ABSTRACT: The vehicle had been started, accelerated and was running on the road. It is now to be stopped. Stopping of the vehicle is as necessary as it starting. Once the vehicle is started, it must be stopped somewhere. Brakes are applied on the wheel to stop the vehicle. The most import and factor in the running and control of the modern vehicle is the braking system. In order to bring the moving motor vehicle to rest are slow down in a shortest possible time, the energy of motion possessed by the vehicle must be converted in to some other form of energy. Kinetic energy is the energy of motion which is converted in to heat given up to air flowing over the braking system. On the early motor vehicle, single shoe brakes were used. They were based on the fact that the heat generated due to friction between the wheel and shoe is proportional to the force pushing the shoe into contact. The greater the force applied to shoe, the quicker is the stoppage of vehicle. But there is a limit to the force applied due to skidding of the wheel over the road. The wheels must be held on the skidding for obtaining the maximum efficiency as well as for controlling the path of the vehicle, which lead to the different types of brake.

KEYWORDS: Disc or rotor, Brake pad, Brake caliper.

1. INTRODUCTION

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The greater the force applied to shoe, the quicker is the stoppage of vehicle. But there is a limit to the force applied due to skidding of the wheel over the road. The wheels must be held on the skidding for obtaining the maximum efficiency as well as for controlling the path of the vehicle, which lead to the different types of brake. Within the caliper are two brake pads, one on each side of the rotor, that clamp together when the brake pedal is pressed. Once again, fluid is used to transfer the movement of brake pedal into the movement of brake pads.

But unlike drum brakes, which allow heat to build up inside the drum during heavy braking, the rotor used in disc brakes is fully exposed to outside air. This exposure works to constantly cool the rotor, greatly reducing its tendency to overheat or cause fading.

Not surprisingly, it was under racing circumstances that the weaknesses of drum brakes and the strength of disc brakes were first illustrated. Racers with disc brake systems could carry their speed deeper into a corner and apply greater braking force at the last possible second without overheating the components.

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II. DISC BRAKE

Though disc brakes rely on the basic principles to slow a vehicle that is friction and heat, their design is far superior to that of the drum brakes. Instead of housing the major components within a metal drum, disc brakes use a slim rotor and small caliper to halt wheel movement.

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Eventually, as with so many other automotive advances, this technology filtered down to the cars driven by everyday people on public roads.

III. CONSTRUCTION

A disc brake assembly consists of the following parts like

- Disc or rotor
- Brake pad
- Brake caliper
- pad wear indicator

DISC (OR) ROTOR

Generally the disc rotor is made of gray cast iron, and is either solid or ventilated. The ventilated type disc rotor consists of a wider disc with cooling fins cast through the middle to ensure good cooling. Proper cooling prevents fading and ensures longer pad life. Some ventilated rotor has spiral fins which creates more air flow and better cooling. Spiral finned rotors are directional and are mounted on a specific side of the vehicle. Ventilated rotors are used on the front of all late model Toyotas.

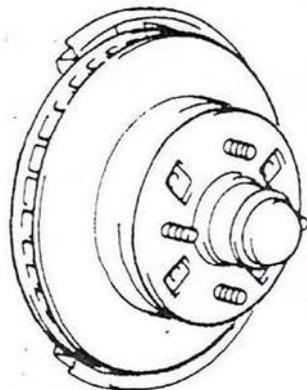


Fig 1: Disc or rotor

BRAKE PAD

Different brake design application requires different kinds of friction materials. Several considerations are weighed in development of brake pads; the coefficient of friction must remain constant over a wide range of temperatures, the brake pads must not wear out rapidly nor should they wear the disc rotors, should withstand the highest temperatures without fading and it should be able to do all this without any noise. Therefore the material should maximize the good points and minimize the negative points.

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Fig2: Brake pad

Materials which make up the brake pad include friction modifiers, powdered metal, binders, fillers and curing agents. Friction modifiers such as graphite and cashew nut shells, alter the function coefficient. Powdered metals such as lead, zinc, brass, aluminum and other metals increase a material's resistance to heat fade. Binders are the glues that hold the friction material together. Phenolic resin is the most common binder in current use. Fillers are added to friction materials in small quantities to accomplish specific purposes such as rubber chips to reduce brake noise.

The brake pad material is bonded to a stamped steel backing plate with a high temperature adhesive to which heat and pressure are applied to cure the assembly. A slit is provided on the face of the pad to indicate the allowable limit of pad wear and provide a path for brake dust and gas to escape.

A metal plate or in some application multiple plates called anti squeal shims, are provided on the piston side of the pad to minimize brake squeal. Various springs and clips are used to reduce rattle as well as reduce brake noise. Shims and plates should be inspected for wear and rust and can be reused when replacing pads. Fresh approved grease should be applied to the shims prior to installation.

BRAKE CALIPER

The caliper also called the cylinder body, houses one to four pistons, and is mounted to the torque plate and steering knuckle or wheel carrier. It is found in floating caliper design or fixed caliper design. The floating caliper design is not only more economical and lighter weight but also requires fewer parts than its fixed caliper counter part. Depending on the application, the floating caliper has either one or two pistons.



Fig 3: Brake caliper

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PAD WEAR INDICATOR

A pad wear indicator has been adopted on some models that produces a high screeching noise when the pad is worn down to a predetermined thickness. The purpose of indicator is to warn the driver and prevent damage to the rotor should the brake pad wear further. The indicator contacts the rotor while the wheel turns and the brakes are not applied. A customer may comment that the noise stops when the brakes are applied. Be sure to install the wear indicators when new pads are installed.

IV. WORKING

When the brakes are applied, pistons inside the caliper are forced outward by master cylinder pressure. The pressure of the piston is exerted through the pads or shoe in a clamping action on the rotor. Since equal opposed hydraulic pressures are applied to both faces of the rotor throughout the application, no distortion of the rotor occurs, regardless of the severity or duration of application. This means smoother stops are possible with disc brakes than with drum brakes.

The frictional energy on the rotor surface creates heat. The heat is easily dissipated to the surrounding air because the rotor is rotating and its surface is not covered because of the rapid cooling characteristic, disc brakes do a better job than drum brakes of resisting brake fade even after successive hard brake application. Resistance to brake fade and smooth stops are the major reasons disc brakes have replaced drum brakes on the front of most vehicles.

COMPARISON OF DISC WITH DRUM BRAKE

Four wheel drum brakes were the standard for decades. In a drum brake, hydraulic pressure is applied to a piston, which in turn forces a curved brake shoe outward. Friction material bonded or riveted to the shoe presses against the inside of the brake drum, slowing the rotation of the drum and the axle.

Actually drum brakes worked well at the time, but anyone try to stop a car from high speed using only drum brakes quickly learns their limitation; they fade. As the brake drum heat up from friction, they expand. The brake shoes have to move out further to contact the drum, which means the brake pedal has to be pressed further. Gases formed from the hot friction material are also trapped between the shoes and the drum interior, reducing braking capability. You must get one good stop from high speed, but try it twice and you were pushing you luck.

ADVANTAGES

- The power of this brake is consistent, effectively regardless of temperature, rim condition, trail conditions right through the life of the brake.
- Better performance in mud than a V-brake. In fact mud seems to hel
- Better mud clearance. So muddy grass catching around your cables.
- Pad wear is minimal.
- There is no pivot to wear.
- The lifetime of the brake is infinite.

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V. SYSTEM FLOW DIAGRAM

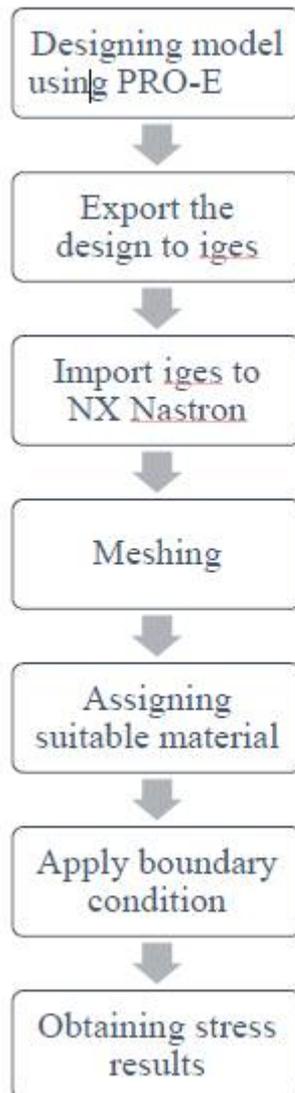


Fig 4: System flow diagram

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VI. RESULT & DISCUSSION

RESULT

Table 1: RESULT

STRESS RESULT- MODEL A

| Disc Brake Rotor | Von-mises Stress Mpa | Temperature °C |
|------------------|-------------------------|-------------------|
| Reference | 338.36 | 130.16 |
| Model A | 415.38 | 350 |
| Model B | 300 | - |

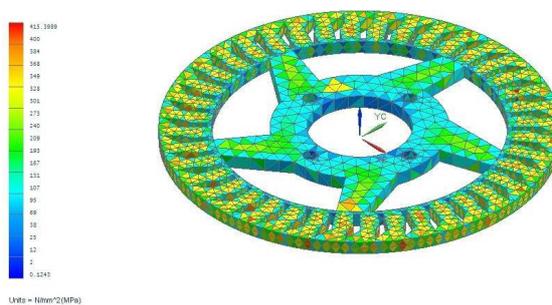


Fig5. Stress result – Model A

TEMPERATURE RESULT – MODEL A

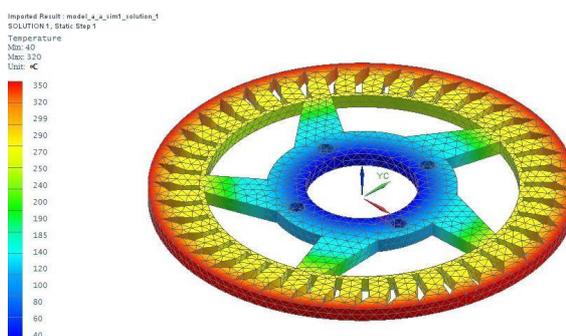


Fig6. Temperature Result – Model A

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REACTION RESULT- MODEL A

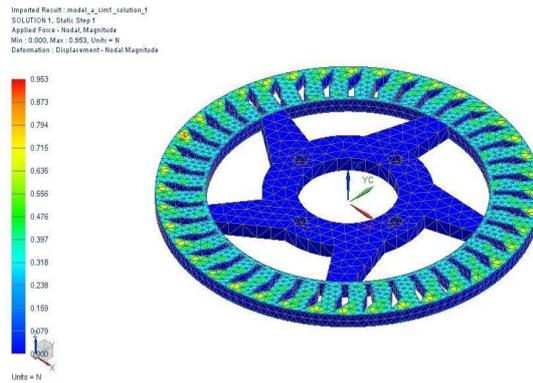


Fig7. Reaction Result – Model A

STRESS RESULT- MODEL B

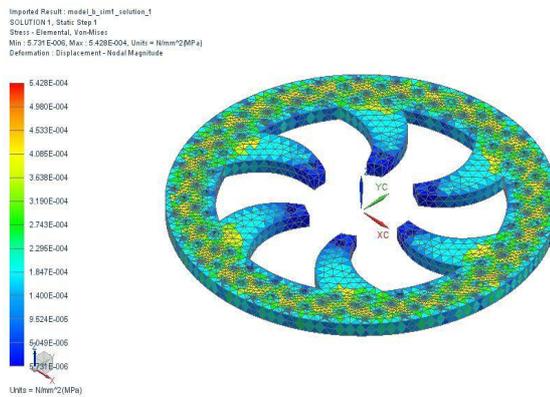


Fig8. Stress Result – Model B

STRESS RESULT - MODEL B (cont.)

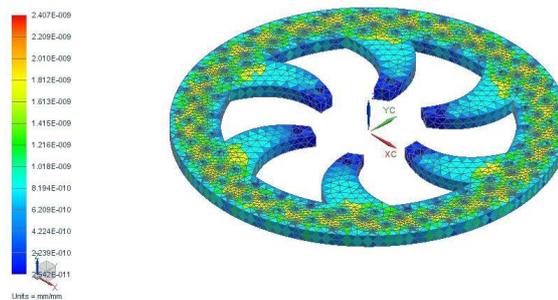


Fig9. Stress Result – Model B

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VII. CONCLUSION

The stress distributions of the two models were compared.

MODEL A

The maximum von-mises stress and Temperature in the model A are 415.38 N/mm² and 350 0C respectively. The maximum von-mises stress and Temperature for reference model are 338.36 N/mm² and 130.16 0C respectively, which was less than the model A.

MODEL B

The maximum von-mises stress in the model A is 300 N/mm². But the maximum von-mises stress for reference model is 338.36 N/mm², which was higher than the Reference Model. Therefore Model 2 cannot be used for disc plate.

Referring above two cases, Model A is better than Existing reference Model.

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