General Idea About Different Material Of Disc Brake For Designing Automobiles

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Abstract—This work carried out for making new optional design for disk braking system with component modified engineering execution, work gives material variants in multiple disc plate structure. Structure build with vane type variants to build its internal strength while disc going under loads in braking. It gives selection of structure option in braking for multi conditional boundary conditions to make feasible disc rotor to prove its workability. Assembly of two disc and vane in between them is feasible found in design also geometry difference in vanes creates strength variable in actual working

I. INTRODUCTION
Mechanical brakes arrest the energy of a machine or object via force, most commonly friction. Most individuals are familiar with automotive brakes, but mechanical brakes are also essential in material handling, manufacturing, and other power transmission applications. Mechanical brakes function via force delivered to a body in rotary or linear motion, such as an axle, shaft, or wheel, to slow or stop motion. Mechanical brakes are often in an assembly with a mechanical clutch for engaging and disengaging shafts. See the mechanical brake and clutch assemblies page for more specific data on these devices. Friction-based brakes utilize a coarse and rugged material (i.e. brake liner) that is tightened or pressed against a body in motion to decelerate. Friction-based braking generates immense heat and some noise, degrading all of the engaged surface areas. Brake capacity decreases with every cycle and requires inspection and replacement. Friction-type brakes are heavily used in automotive applications.

Disc braking fundamentals
Engagement
Friction Brakes Significant force is required to decelerate components from friction. Brakes that rely solely on manual power supplied by the operator are the purest form of mechanical brake and many need to be self-energizing to be effective. Dual-function brakes are those that utilize two sources for actuator power, such as pneumatic-mechanical or hydraulic-mechanical. For example, in passenger automobiles the operator depresses a pedal that compresses brake fluid in a linked master cylinder. The master cylinder converts this into hydraulic pressure that actuates the slave cylinders that ultimately provide the braking force. A vacuum servo often helps the driver obtain the foot pressure necessary to pressurize the hydraulic system. Similarly, large commercial vehicles often use pneumatic-mechanical braking systems (i.e. air brakes). Lever force is the total available braking power from an individual system. This force must be sufficient to decelerate the shaft within a specified time (i.e. braking force).

A. Disengagement
Complete release of mechanical brakes results in brake drag that shortens braking components service life and also wastes energy. For many friction brakes, a spring holds the brake in the disengaged position until a force overcomes the spring preload. Brakes can also be supplied as fail-safe brakes, or brakes where the spring keeps the brake engaged and power is needed to remove the spring's braking force. For band brakes, disengaging the brake requires loosening the brake band, which can be done automatically when the shaft is stopped (as with self-energizing brakes) or by releasing the brake lever or other activation mechanism. The brake spring in wrap-spring clutches and brakes automatically releases when the shaft has stopped.

II. MATERIALS
Brake lining materials vary considerably by application. Materials must be soft, tough, heat resistant, and possess a high coefficient of dynamic friction. They are applied to pads or shoes made of welded or riveted sheet metal.
Non-metallic - composite organic or synthetic materials, including cellulose, aramids, polyacrylnitrile, and sintered glass. Non-metallic linings minimize rotor wear, but have short service lives.
Semi-metallic - composite materials filled with metallic flakes to improve wear resistance and service life with increased wear on the rotor or drum; requires higher braking torque.
Metallic - often reserved for performance or high energy applications; composed of sintered steel that wears quickly on rotors, requires higher braking torque, and generates noise.

Ceramic - clay and porcelain mixed with copper flakes and filaments. Moderate durability, lifespan, and torque requirements with zero perceived sound. However high operating temperatures can warp pads and other components. Calipers are typically metal plates with cylinders made of plastic, aluminum, or chrome-plated steel. Disc materials include:

Ceramic composite - carbon fiber-reinforced ceramic provides stable friction at high speed and all temperatures, is 50% lighter than grey iron, but is also quite expensive.

Grey iron - cast iron with graphitic microstructure that has high heat and damping capacities with wear resistance and machinability. It is the most common material for automobile rotors.

Steel - stainless steel is commonly integrated into bicycle and motorcycle brakes, however has poor thermal conductivity. Steel may be acceptable for applications with higher thermal requirements, but will also corrode.

Aluminum - a lightweight metal with excellent thermal characteristics; only suitable for low RPM applications because of decreased wear resistance and strength; sometimes found on bicycles.

Titanium - only compatible with organic or resin-based liners; lightweight with good strength and corrosion resistance, but has low surface friction and lifespan.

Specifications

Lever force - the total available force that a braking system can apply

Response time - the lag between the braking command and engagement of the mechanism, typically in milliseconds.

Braking capacity - the cumulative decelerative effect of brake pad surface area and actuator force (excluding variables such as road conditions, wind resistance, etc.).

Speed - the maximum axle rotational speed compatible for a given mechanical brake, typically in RPM

Power - the maximum horsepower (HP)

Braking torque - the force needed to halt a disc or drum in a specific timeframe (ft.-lb.)

Torque rating - maximum torque that can be applied to a rotating component in foot-pounds (ft.-lb.)

Peak force - the maximum pressure that can be applied by the actuator

Continuous power dissipation - the power that the brake can withstand before failing

Brake lining service life - depends on force applied, material, cycling, and operating temperatures.

Static torque - the force applied to the disc, drum, or shaft to prevent rotation when stopped or parked

Tensile strength - wrap-springs can only transmit torque that doesn't exceed their material strength

Torque-to-size ratio - the ratio of brake diameter to braking torque

Anti-back/anti-overrun torque - torque to eliminate backward or bouncing movements by the shaft when stopped.

III. ANALYSIS APPROACH

1. CARBON CERAMIC MATRIX

2. GRAY CAST IRON

Carbon Ceramic Matrix

The entire characteristic profile makes fiber-reinforced silicon carbide to a first-choice material for high-performance brake systems: in particular the low weight, the hardness, the stable characteristics also at high pressure and temperature, the resistance to thermal shock and the quasiductility provide long life time of the brake disc and avoid all issues, which are typical for cast iron brake discs.

The resulting quasiductile properties of the ceramic composite material combine the useful properties of carbon fiber-reinforced carbon (C/C) and polycrystalline silicon carbide ceramics. The deformation at breaking point of C/SiC materials ranges from 0.1 to 0.3 %. This is an

A special feature of the carbon ceramic brake discs is represented by the ceramic composite material. This material is obtained through a particular process, which gives the possibility to add or deposit a layer of material to improve the friction coefficient on both the braking surfaces.

The core and the additional friction layer are made by a composite material, which is composed by carbon fibers (reinforcement), silicon carbide and metallic silicon (matrix).

Silicon carbide, the main matrix component, assures great hardness for the composite material while carbon fibers guarantee high mechanical strength resistance, providing the fracture toughness required in this kind of applications.
The carbon-ceramic brake disc has a production process over approximately 20 days.

To produce carbon-ceramic brake discs, we use carbon fibers which are given a special protective coating and then cut into short fiber sections of defined thickness and length. The fiber can be used directly or can be treated in order to obtain a complex row material called “carbochip”. The production process starts with a mixture of the component and ends with the assembling of the rotor and the bell. The production process of the ceramic brake body requires a preform pressed with binding resin to a so called green body which will be converted in the ceramic component by first carbonizing at 900 °C and second by liquid silicon infiltration (siliconization) at 1700 °C in vacuum atmosphere.

One of the complex features of the manufacturing process is the use of the “lost core” technology – a plastics matrix which defines the design of the cooling channel geometry and which burns out without residues at carbonizing. Another complex feature is the use of different fiber components of the brake disc body, the friction layers on the ring exterior side and the point-shaped abrasion indicators which are integrated into the friction layer. The final machining also require high technology because the hardness of the material force the use of diamond tools.

The advantages of these material disks are:
Very little wear, resulting in lifetime use for a car with a normal driving load of 300,000 km, is forecast by manufacturers. No fading is experienced, even under high load. No surface humidity effect on the friction coefficient shows up, as in C/C brake disks. The corrosion resistance, for example to the road salt, is much better than for metal disks. The disk mass is only 40% of a metal disk. This translates into less unsprung and rotating mass. The weight reduction improves shock absorber response, road-holding comfort, agility, fuel economy, and thus driving comfort. The Si C-matrix of LSI has a very low porosity, which protects the carbon fibres quite well. Brake disks do not experience temperatures above 500 °C for more than a few hours in their lifetime. Oxidation is therefore not a problem in this application. The reduction of manufacturing costs will decide the success of this application for middle-class cars.

Gray Cast Iron Brake Rotor Metallurgy

The properties of cast iron components are controlled by the microstructure of the material, which consequentially are determined by the chemistry and processing of the cast iron.

Gray Cast Irons

• Gray cast iron forms graphite flakes during solidification. The gray iron microstructure is due to slow solidification rates and silicon alloying that promotes graphite formation. Gray irons typically have low ductility and moderate strength, but they have high thermal conductivity and excellent vibration damping properties. Gray irons get their name from their dull gray fracture features.
Gray Cast Iron Classifications and Mechanical Properties

<table>
<thead>
<tr>
<th>Casting Grade</th>
<th>Typical Carbon Content (%)</th>
<th>Theoretical Minimum Tensile Strength (MPa)</th>
<th>Typical Brittle Hardness Range (BH)</th>
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<td>Previous</td>
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<tr>
<td>G13 G4000</td>
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<td>3.15 - 3.40</td>
<td>268</td>
</tr>
</tbody>
</table>

Mechanical Properties of Gray Cast Irons

Elastic modulus is lower than that of steels and nodular iron, and it is non-linear. Elastic modulus decreases with increasing graphite content.

• Gray cast irons exhibit very little ductility. Typical elongations in tensile testing are less than 0.5%. • Impact strength and notch sensitivity are poor due to the graphite flakes acting as stress risers. Fatigue strengths of gray cast irons are low due to effects of the graphite flakes on crack initiation.

IV. CONCLUSION

It gives selection of structure option in braking for multi conditional boundary conditions to make feasible disc rotor to prove its workability. Assembly of two disc and vane in between them is feasible found in design also geometry difference in vanes creates strength variable in actual working.

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