Review: Life Increment of Disc Break Pads Using Various Materials by CAE Tools

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Abstract:
Brake pads are a component of disc brakes used in automotive and other applications. Brake pads are steel backing plates with friction material bound to the surface that faces the disk brake rotor. In this present paper first of all find out the brake pads which is used in automobile industries and laboratory testing of the material is proceed and then thermo mechanical analysis is done for the finding out the stresses and maximum temperature. The analysis is done in ANSYS. Then Find out the materials which give the more life.

Keyword: *Analysis Software, Brake Pads, Laboratory testing*

1. Introduction

Brake pads convert the kinetic energy of the car to thermal energy by friction. Two brake pads are contained in the brake caliper with their friction surfaces facing the rotor. When the brakes are hydraulically applied, the caliper clamps or squeezes the two pads together into the spinning rotor to slow/stop the vehicle. When a brake pad is heated by contact with a rotor, it transfers small amounts of friction material to the disc, turning it dull gray. The brake pad and disc (both now with friction material), then "stick" to each other, providing the friction that stops the vehicle.

In disc brake applications, there are usually two brake pads per disc rotor, held in place and actuated by a caliper affixed to a wheel hub or suspension upright. Although almost all road-going vehicles have only two brake pads per caliper, racing calipers utilize up to six pads, with varying frictional properties in a staggered pattern for optimum performance. Depending on the properties of the material, disc wear rates may vary. The brake pads must usually be replaced regularly (depending on pad material), and most are equipped with a method of alerting the driver when this needs to take place. Some have a thin piece of soft metal that causes the brakes to squeal when the pads are too thin, while others have a soft metal tab embedded in the pad material that closes an electric circuit and lights a warning light when the brake pad gets thin. More expensive cars may use an electronic sensor.

1.1. Materials of Brake Pads

Brake pad materials range from asbestos to organic or semi-metallic formulations. Each of these materials has proven to have advantages and disadvantages regarding environmental friendliness, wear, noise, and stopping capability.

- Asbestos
- Semi-Metallic
- Non-Asbestos Organics
- Low Steel
- Carbon
- Exact composition of each manufacturer's pads is a closely guarded secret

1.2. Semi-Metallic Materials

The most common brake pads for vehicles today are semi-metallic. These brake pads are composed of metal shavings held together with resin. Some of the most common metals are copper, brass, and steel. Because they are crafted of primarily metal, these brake pads are very durable and can last a long time before needing replacement. They are also relatively inexpensive. However, their metallic nature also subjects them to more grinding noises, considering they are being rubbed against a metal brake rotor for the purpose of creating friction. Each manufacturer has its own formulation for brake pad materials, and it is generally a highly guarded secret formula. Many after-market brake pads are touted as being quieter than the standard versions.

- Low to medium coefficient of friction ~ 0.28 –0.38
- Relatively high mu variation (temperature, duty cycle)
- Good fade characteristics
- Poor wear at low temps., <100C
- Excellent wear at temps. over 200C
- Good wear under heavy loads
- Poor wear at high speeds
- Generally inferior Noise, Vibration & Harshness compared to NAOs
- Contains no copper
- Low initial cost
- High fluid temperatures can be an issue

Table 1: Advantage Disadvantage of Materials

Material	Advantages	Drawbacks
Semi-Metallic	Readily available; inexpensive; good performance; durable	Causes quicker wear on rotors; heaviest, impacting gas mileage; needs time to warm up
Organic	Quieter; environmentally friendly	Wear quickly; create more dust
Ceramic	Best performance; incredibly durable; lightweight	Expensive

2. Literature Review

Amira Sellami, Mohamed Kchaou, Riadh Elleuch[1]. The interaction between microstructure, mechanical, and frictional properties of a commercial brake lining material (BLM) was investigated in order to correlate them to braking performance. For this purpose, a Scanning Electron Microscope (SEM) with energy dispersive X-ray (EDX) mapping and spectrum were used to identify and analyze different constituents. The mechanical properties were determined using compression test. Relevant physical properties (density and porosity) were determined using standard test methods. The friction coefficient and wear behavior of the friction material on contact with the grey cast iron disc were established using a pad-on disc tribometer. The results have shown that the brake lining material contains phenol resin such as the matrix and other various ingredients, including silica, rock and mineral filler reinforcement, barium sulfate and carbon-rich particles as filler and brass particles as friction modifier. It had a varied amount and size up to 1 mm for brass particles. The density and porosity were 1.8 g cm_3 and 7%, respectively. The investigated material exhibited excellent mechanical properties in the normal solicitation direction. The average friction coefficient was about 0.65, whereas the friction coefficient was stable. The different actions of various ingredients in terms of their effects on the friction and wear behavior of the BLM could be related to their different bonding strengths with the resin matrix and their different abilities to form friction films (third-body layer) on the surfaces of the material and transfer films on the counterpart cast iron surface in relation to the surface temperature evolution and mechanical properties.

L. Lasa, J.M. Rodriguez-Ibabe[2]. Testing was conducted using a pin-on-disc configuration and two different testing speeds,At lower disc speed, the influence of the composition and alloy processing was very strong and a severe wear transition was observed for the alloys with low fractions of primary silicon particles. At higher disc speed, wear of all the alloys but one was very low. The high wear alloy had a high silicon content and a very large primary silicon size; the accelerated wear was caused by cracking and fracture of the large silicon particles upon impact with the abrasive disc material at the higher speed

U.D. Idris[3]. A new brake pad was produced using banana peels waste to replaced asbestos and Phenolic resin (phenol formaldehyde).The resin was varying from 5 to 30 wt% with interval of 5 wt%.The results shown that compressive strength, hardness and specific gravity of the produced samples were seen to be increasing with increased in wt% resin addition,while the oil soak, water soak, wear rate and percentage charred decreased as wt% resin increased

K.K. Ikpambese[4]. The results obtained indicated that the wear rate, coefficient of friction, noise level, temperature, and stopping time of the produced brake pads increased as the speed increases. The results also show that porosity, hardness, moisture content, specific gravity, surface roughness, and oil and water absorption rates remained constant with increase in speed. increasing the smoothness of the friction materials.

Sai Balaji M.A[5].A new semi metallic friction material formulation with high coefficient of friction 0.46 and low wear 4.65% was optimized by the golden section approach. The optimal properties of the seven ingridients including Zicrosil, barites, copper chips, Synthetic graphite, NBR, steel wood, and alkyl Benzene phenolic resin selected. According to their wear resistance in friction formulation were searched in three phase. The formulation tested were performed in three phase and the composition of the ingridients were proportionaly changed using the golden section sequence.

M.K. Abdul Hamid[6]. Changes in friction and contact surfaces characteristics of a brake friction material during drag and stop mode test were investigated using a brake model tribo-tester. Scanning Electron Microscopy (SEM) was utilized to reveal the surface topography characteristics and analyze the external particle size effects on friction coefficients and grit embedment. Silica sand with three different particle sizes of 50-180 μm, 180-355 μm and 355-500 μm was used in this work. From this study, the experimental results showed that the external grit particles have significant effect on CoF values especially with the bigger particle which reduces the sensitivity of the CoF at lower speeds. Higher CoF values and more stable contact were recorded with small particles which actively involved in building up and increasing the rate of changes of the effective contact area. Also average CoF values tend to increase with speed for all the cases with presence of grit particles due to faster mixing of grit particle with other contaminants and GE was greatly dependent on presence of compacted wear debris. Lastly, the sliding speed and applied pressure significantly influence the percentage and level of particle grit embedment.

3. Objective

First of all, now a day in Automobile Cars which material Brake Pads is used is study. Then Laboratory testing of this materials.Then thermal analysis of the materials is proceed.The Brake pads life is 20,000km.Now my project is based on the Increment in the Brake pads life.So that, find out the Brake pads which give the more life

4. Analytical Setup

Thermal analysis is a vital stage in the study of brake systems, because the temperature determines the thermomechanical behavior of the structure. In the braking phase, temperatures and thermal gradients are very high. This generates stresses and deformations whose consequences are manifested by the appearance and the accentuation of cracks. It is thus important to determine with precision the temperature field of the brake disc. During stop braking, the temperature does not have time to be stabilized in the disc. A transient analysis is required. It is also essential to evaluate the thermal gradients, which requires three-dimensional modeling of the problem. The thermal loading is represented by a heat flux entering the disc through the brake pads. Many studies of brake disc thermomechanical coupling analysis have been done

Here is the analysis work in ansys. By the use of the Finite Elements Method is used for the analysis and for the analysis, properties of the materials is require so that here is the properties of materials.

Table 2: Properties of Materials

Sr No.	Properties	Value	Sr No.	Properties	Value
1	Material	Semimetalic	**9**	Torque-	737.28 N.mm
2	Young's modulus	12.19 Gpa	**10**	RPM-	1130
3	Poisson's ratio	0.26	**11**	Stopping time-	2.9 sec.
4	C.O.F	0.35 to 0.45	**12**	Density-	1400 Kg/m^3
5	Compressive Strength	61.20 N/mm^2	**13**	Thermal conductivity	5 w/m˚C
6	Force	6319.31 N	**14**	Specific Heat-	1000 J/Kg ˚C
7	Velocity	60 Km/h	**15**	Thermal expansion	1o (10^-6/˚C)
8	Elastic modulus-	1Gpa.			

5. Conclusion

The analysis is completed in ansys by the FEM and the result of the analysis is in the form of the stresses and the maximum temperature of the materials. So that by this results the maximum principle stress and the von misses stress , deformation ,directional deformation, heat flux, maximum temperature of the material is known. So that find out the new materials which give the more life as compare to this existing material and the thermal and physical properties of materials is better as compare to the existing materials.

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