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Design of Dual calipers for High-speed Vehicles

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Abstract: Breaks plays a vital role in automobiles to decelerate the vehicle. In early days vehicles were used simple breaking system and it is developed to disk break with single callipers for better efficiency. In the current paper we are replacing single callipers disk break to double callipers disk break, so that the breaking system is more effective and imparts better performance. In this breaking system calipers are used to squeeze the pads against the rotational disc, in which it generates the friction and get stops the vehicle.

Keywords: calipers, disk, break

1. LITERATURE SURVEY:

To investigate the temperature fields of the solid disc brake during short, emergency braking. Transient thermal analysis of disc brakes in single brake application was performed. the numerical simulation parabolic heat conduction equation is obtain for two dimensional model. The results show evolution of rotating speed of disc and contact pressure with specific material properties ***Piotr GRZEŚ*** [1].

The contact pressure distribution of a solid disc brake helps for structural modifications. It helps to find the contact pressure distributions obtained from these four models are quite different. This suggests that one should be careful in modeling disc brakes in order to obtain correct contact pressure distributions. This work could help design engineers to obtain

a more uniform pressure distribution and subsequently satisfy customers' needs by making pad life longer. ***Abd Rahim Abu-Bakar, Huajiang Ouyang*** [2]

hydraulic pressure, the rotational velocity of the disc, the friction coefficient of the contact interactions between the pads and the disc, the stiffness of the disc, and the stiffness of the back plates of the pads, on the disc squeal are finded. The squeal can be reduced by decreasing the friction coefficient, increasing the stiffness of the disc, using damping material on the back plates of the pads, and modifying the shape of the brake pads. ***P. Liu a, H. Zheng a, C. Cai a, Y.Y. Wang a, C. Lu a,K.H. Ang b, G.R. Liu*** [3]

2. BRAKES:

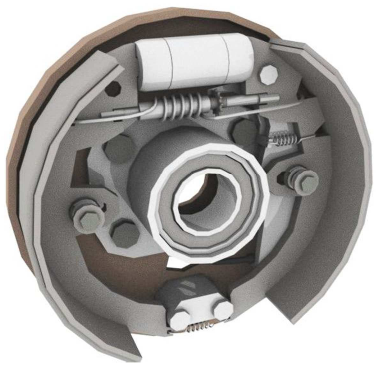
- A brake is a mechanical device that inhibits motion by absorbing energy from a moving system. It is used for slowing or stopping a moving vehicle, wheel, axle, or to prevent its motion, most often accomplished by means of friction.
- Most brakes commonly use friction between two surfaces pressed together to convert the kinetic energy of the moving object into heat, though other methods of energy conversion may be employed.

There are generally two types:

1. Drum Brake
2. Disc Brake

DRUM BRAKE:

- The brake that uses friction which is caused by set of shoes or pads in which it press the outward against a rotating cylinder shaped part is called drum brake. It generally consists of a brake drum, back plate, brake shoe, brake liners, retained springs, cam and brake linkages.



DISC BRAKE**:**

- The brake uses calipers to squeezes the pads against the rotation disc in which it creates the friction and get stops the vehicle, this is called as disc brake. It generally consists of a disc, calipers and friction pads.

3. MATERIAL SELECTION:

Grey cast iron is an attractive material used in industrial applications due to its some advantageous properties such as good cast ability, corrosion resistance, machinability, low melting point, low cost and high damping capacity. It is used widely in the manufacturing of some machine components, disc brake rotors and hydraulic valves.

Grey cast iron is widely used because of its low cost and ease of manufacturability whereas aluminium is less likely used because of its high cost and wear rate**.** Aluminium has lower density and higher thermal conductivity as compared to the conventionally used grey cast irons and are expected to result in weight reduction of up to 50-60 % in brake system.

Cast iron is one of the oldest ferrous metals in commercial use. It is primarily composed of iron (Fe), carbon (C) and silicon (Si), but may also contain traces of sulfur (S), manganese (Mn) and phosphorus (P). It has a relatively high carbon content of 2% to 5%. It is typically brittle and nonmalleable (i.e. it cannot be bent, stretched or hammered into shape) and relatively weak in tension. Cast iron members tend to fracture with little prior deformation. Cast iron, however, has excellent compressive strength and is commonly used for structures that require this property. The composition of cast iron, the method of manufacture and heat treatments employed are critical in determining its final characteristics. The popularity of grey cast iron components is because grey iron is one of the cheapest types of iron castings to produce. Grey Iron is also excellent in its ability to dampen vibrations Grey iron has high thermal conductivity meaning it moves heat more easily through the metal.

4. CALCULATIONS:

Specifications:

Total mass of vehicle =130 kg
Maximum velocity = 140 kmph
Disc diameter = 190 mm
Coefficient of friction = 0.3
Pedal ratio = 4:1
Master cylinder diameter = 9 mm
Caliper piston diameter = 33 mm
Piston stroke = 57.8 mm
Pad Area = 1500

For Single Calliper

1. Work done in Kinetic Energy:

$$K.E = 1/2mv^2$$
$$= 1/2*130*(140*5/18)^2$$
$$K.E = 98\ KJ$$

2. Pressure on master cylinder:
$P=F/A$
Consider if driver applies 30 kg weight force coming from the pedal
F=Force on master cylinder = ma
= 30*9.81*4
= 1177.2 N
A=Area of master cylinder = $\pi r^2 = \pi*(9/2)^2$
= 63.61 mm^2
P = 1177.2/63.61
P = 18.506 N/mm^2

3. Force on Caliper (Assuming no loss): Pressure of master cylinder = Pressure of caliper FC = P*pad area
= 18.506*1500
FC = 27759 N

4. Rotating force:
F = FC*μ
= 27759*0.3
F = 8327.7 N

5. Deceleration**:**
a = FC/M
= 27759/130
= 213.530 M/S^2

6. Braking Torque:
T = 2μFCr
= 2*0.3*27759*95
T = 1582263 N-mm

7. Stopping Distance:
$V^2 – U^2 = 2aS$
$S = (V^2 – U^2)/2a$
$= 0 – (140*5/18)^2/2*213.530$
S = 3.54 m

8. Braking Time:
V = u + at
t = v – u/a
= 140/213.53
t = 0.655 sec

For Dual Calliper

1. Work done in Kinetic Energy**:**
$K.E = 1/2mv^2$
$= 1/2*130*(140*5/18)^2$
K.E = 98 KJ

2. Pressure on master cylinder:
$P=F/A$
Consider if driver applies 30 kg weight force coming from the pedal
F=Force on master cylinder
= ma
= 30*9.81*4
= 1177.2 N
A=Area of master cylinder
$= \pi r^2 = \pi*(9/2)^2$
= 63.61 mm^2
P = 1177.2/63.61
P = 18.506 N/mm^2

3. Force on Caliper (Assuming no loss):

Pressure of master cylinder = 2*Pressure of single caliper

$FC = 2* 18.506\ N/mm^2$

$= 2*18.506*1500$

$FC = 55518\ N$

4. Rotating force:

$F = FC*\mu$

$= 55518*0.3$

$F = 16655.4\ N$

5. Deceleration**:**

a = FC/M

$= 55518/130$

$= 427.06\ M/S^2$

6. Braking Torque:

$T = 4\mu FCr$ (braking torque of single caliper)

$T = 4*0.3*55518*95\ N/mm^2$

$T = 6329052\ N/mm^2$

7. Stopping Distance:

$V^2 – U^2 = 2aS$

$S = (V^2 – U^2)/2a$

$= 0 – (140*5/18)^2/2*427.06$

$S = 1.7706\ m$

8. Braking Time:

$V = u + at$

$t = v – u/a$

$= 140 – 0/427.06$

t = 0.327sec

5. RESULT

Compared in parameters like stopping time and stopping distance in dual calipers is less compared to single calipers by this we can say that dual calipers reduces time factor so that the stopping can be done in quick time and it is useful to avoid accidents.

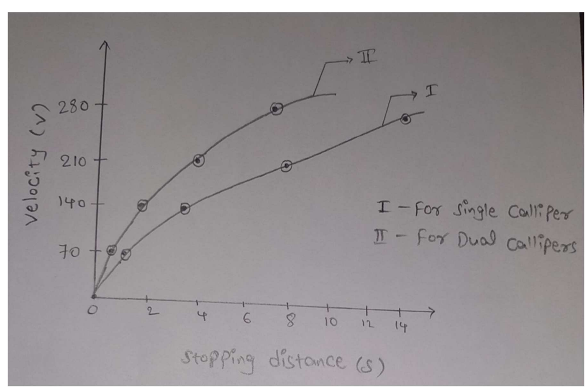


Fig 1: Velocity(V) Vs Stopping Distance(S)

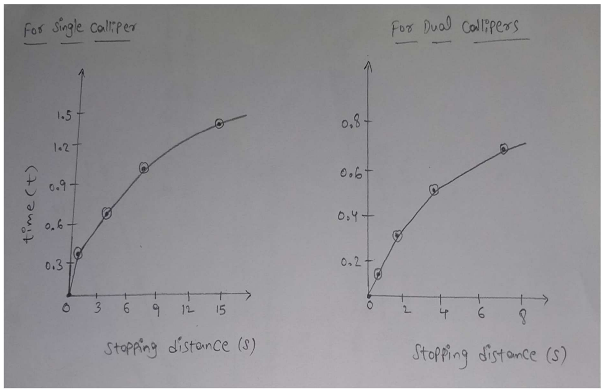


Fig:2. Time Vs Stopping Distance(S)

REFERENCES:

[1] A Text book of Theory of machines by R.S. Khurmi and S.Chand.

[2] A Design data hand book by Md. Jalaludeen.

[3]Finite Element Analysis for Engineering & Tech. Author, T. Chandrupatla. Edition illustrated. Publisher, Universities Press, 2004.ISBN, 8173714274.

[4] ISBN-10: 1932709444 ISBN-13: 978-1932709445 Pro/ENGINEER Wildfire 4.0 for Designers textbook is a comprehensive textbook that introduces the users to Pro/ENGINEER Wildfire 4.0,

[5] Machine Design Edition: 14th. Author: R.S. Khurmi& J.K. Gupta

[6] Analysis of Ventilated Disc Brake Squeal Using a 10 DOF Model," SAE Technical Paper 2012-01-1827, 2012.

[7] A Textbook of Machine Design by R S Khurmi and GUPTA.

[8] G. Babukanth & M. Vimal Teja. Transient Analysis of Disk Brake By using Ansys Software

.

[9] Ali Belhocine, MostefaBouchetara. Thermal analysis of a solid brake disc, Applied ThermalEngineering 32(2012) 59-67.

[10] V. M. M. Thilak, R. Krishnaraj, Dr. M.S Akthivel, K. Kanthavel, Deepan Marudachalam M.G, R. Palani. Transient Thermal and Structural Analysis of the Rotor Disc of Disc Brake,International Journal of Scientific & Engineering Research Volume 2, Issue 8, August-2011.

[11] Ameer Fareed BashaShaik, Ch.LakshmiSrinivas. Structural and thermal analyses of discbrake with and without cross drilled rotor of race car, International Journal of Advanced Engineering Research and Studies.

[12] GONSKA, H. W. AND KOLBINGER, H. J. Temperature and Deformation Calculation of Passenger Car Brake Disks, Proc. ABAQUS User's Conference, Aachen, Germany, page21- 232, (1993).

[13] AKIN, J. E. Application and Implementation of Finite Element Methods, Academic Press, Orlando, FL, page 318-323, (1982).

[14] ZAGRODZKI, P. Analysis of thermo mechanical phenomena in multi disk clutches and brakes, Wear 140, page 291-308, (1990).

[15] COOK, R. D. Concept and Applications of Finite Element Analysis, Wiley, Canada, (1981).

[16] ZIENKIEWICZ, O. C. The Finite Element method, McGraw-Hill, New York, (1977).

[17] BEEKER, A.A. The Boundary Element Method in Engineering, McGraw-Hill, New York, (1992)

.

[18] Vandana Gupta and S.B. Singh, "Mathematical Model of Creep Behavior in an AnisotropicRotating Disc of Al-Sicp with Thickness Variation in Presence of Thermal Residual Stress",International Journal of Mechanical Engineering & Technology (IJMET), Volume 3,Issue 2, 2012, pp. 274 - 283, ISSN Print: 0976 – 6340, ISSN Online: 0976 – 6359.

[19] Dr.S.B.Chikalthankar, Dr.V.M.Nandedkar and S.L.Thengade, "A Review & Literature ofFrictional & Wear Characteristics of Non-Asbestos Brake Pad using Link Chase Machine",International Journal of Mechanical Engineering & Technology (IJMET), Volume 5,Issue 1, 2014, pp. 140 - 145, ISSN Print: 0976 – 6340, ISSN Online: 0976 – 6359.