Calculations without brake booster engineering essay

The purpose of this written assessment is to show that we understand how the braking system works in an automotive vehicle. We should be able to show a range of specialized technical skills which involve a wide choice of standard and non standard procedures. I will also show you a broad knowledge base with substantial depth in some areas of the braking system. Here in this assignment I will also cover the determination of appropriate methods and procedures in response to a range of concrete problems with some theoretical elements and apply it in self directed and sometimes directive activity, within broad general guidelines. By the end of this assessment I will have a wide understanding of how the braking design and braking system work within the automotive vehicle.

A brake is a device for slowing or stopping the motion of a vehicle or a machine, and to make sure that it stops moving. The kinetic energy lost by the moving part is usually translated to heat by friction. Alternatively, in regenerative braking, the energy is recovered and stored in a flywheel, capacitor or other device for later use.

Brakes of some description are fitted to most wheeled vehicles, including automotive vehicles of all kinds, trains, motor bikes, and normal pedal bikes.

“ The kinetic possessed by a vehicle at any one time into heat energy are by means of friction. The equations for kinetic energy, that is the energy of motion may be given by:

The disc brake is a device for slowing or stopping the rotation of a wheel on a vehicle. A braking disc or commonly known as a rotor, is usually made up of steel and other metallic compounds, is connected to the wheel or the axle.

To stop the wheel, the braking pads which are normally mounted in a device called a brake caliper, which is then squeezed mechanically or hydraulically against the disc on both sides. Friction causes the disc and attached wheel to slow down and stop according to the driver.

A drum brake is a brake in which the friction is caused by a set of shoes or pads that press against the inner surface of a rotating drum. The drum is connected to a rotating wheel. The modern automotive vehicle drum brake was invented in 1902 by Louis Renault. In the first drum brakes, the shoes were mechanically operated with levers and rods or cables. From the mid 1930’s the shoes were operated with oil pressure in a small wheel cylinder and pistons, though some vehicles continued with purely-mechanical systems for decades. Some designs have two wheel cylinders.

Experiments with disc-style brakes began in England in the 1980’s the first ever automobile disc brakes were patented by Frederick William Lanchester in his factory in 1902, though it took another half century for his innovation to be widely adopted. The first designs resembling modern disc brakes began to appear in Britain in the late 1940’s and early 1950’s. They offered much greater stopping performance than comparable drum brakes, including much greater resistance to brake fade this is caused by the overheating of brake components, and were unaffected by immersion which is drum brakes were ineffective for some time after a water crossing, an important factor in off-road vehicles. Disc brakes are also more reliable than drum brakes due to the simplicity of their mechanics, the low number of parts compared to the drum brake, and ease of adjustment.

Disc brakes were most popular on sports car when they were first introduced, since these vehicles are more demanding about brake performance. Many early implementations located the brake disc inboard, near the differential, but most discs today are located inside the wheels. An inboard location reduces the un-sprung weight and eliminates a source of heat transfer to the tires, important in formula one racing. Discs have now become standard in most passenger vehicles, though some retain the use of drum brakes on the rear wheels to keep costs and weight down as well as to simplify the provisions for a parking brake or emergency brake. As the front brakes perform most of the braking effort, this can be a reasonable compromise.

Mechanism

A single piston, floating caliper system.

Pressurized brake fluid travels along the brake line to the caliper. The pressurized fluid pushes the piston (green) and inner brake pad against the disc which is normally blue. Pressure against the disc pushes the caliper away from the piston, pulling the outer brake pad against the disc. As the brake pads clamp together, friction slows the rotation of the disc and wheel.

Brake Pads

The world of Automotive Brakes can be quite overwhelming. The first task in choosing Automobile Brakes is making sure that you have the Automotive Brakes and parts that are application specific to your vehicle whether it be a car, truck, van or whether the Automotive Brakes are to be installed on a two year old sedan or a rare classic. There is more to Automotive Brakes than parts that fit. Automotive Brakes also have to be right for the vehicle’s actual use. For example, Automotive Brakes required for off road or stop and go city delivery driving can be quite different than Automotive Brakes that are suited for ordinary “ family” driving, even though all these brakes “ fit” the job. It’s a matter of finding the right Automotive Brakes for your application.

Brake Pads

Brake Booster

Unless you’re a professional athlete with tree trunks for legs, be grateful that your car has a brake booster nestled between the brake master cylinder and firewall on your car. Your brake booster doesn’t make any noise, and it doesn’t use any electricity or gasoline, but it ensures that you can stop your car with only a light touch of the brake pedal. Things weren’t always like that, Before the invention of the vacuum brake booster, cars still stopped. It’s just that you had to really stomp on the brake pedal. The modern brake booster is an good device that operates using something that your engine generates whenever it’s running, Vacuum. The brake booster takes engine vacuum via a rubber hose that runs from the intake manifold, and the brake booster uses that vacuum to amplify the pressure you put on the pedal. A light application of the brakes is translated by the brake booster into significantly more pressure on the brake master cylinder, ensuring that your car stops quickly.

So what happens to the brake booster if your car stalls, resulting in a loss of engine vacuum?

Early designers realized that gas engines were hardly foolproof, so they designed a little check valve into the brake booster circuit. The brake booster stores enough vacuum to provide full boost for two or three pedal applications even after the engine dies. The check valve on the brake booster is what keeps that vacuum from leaking out. And speaking of leaks, that's the reason most brake booster units have to be replaced. As your brake booster ages, the rubber seals and diaphragms that hold the vacuum tend to wear out and crack.

Brake Booster

Calculations without brake booster for 1 pot caliper:

Data:

Force applied: 80N

Length of brake pedal: 340mm

Pedal movement: 46mm

Diameter of master cylinder: 26mm

Piston spring pretension: 15N

Piston spring rate: 8N/mm

Wheel diameter: 0. 30/ 250mm

Caliper piston: 46mm

Pedal ratio= Length of pedal

Pivot of brake booster

= 340mm

60mm

= 5. 666

Movement = Pedal movement

Pedal ratio

= 46mm

5. 66

= 8. 127

Drivers applied force = Applied force x pedal ratio

= 80n x 5. 66

= 452. 8N

Piston force = (Pretension force + Rate of spring x movement of piston)

= 452. 8N – (15n + 8N/m x8. 127)

= 452. 8N – 80. 016

= 372. 784 N

Pressure = Force

Area of piston

= 372. 784 N

0. 25TT D2

= 372. 784 N

0. 25TT (26 x 10 -3) 2

= or 0. 70 Mpa

Caliper force = Pressure x Area

= 7021. 35 Pa x 0. 25 TT (46 x 10-3)2

= 1270. 55

Transmitted force = Caliper force x Co- efficient of friction x number of pads

= 1270. 55N x 0. 35 x 2

= 8893. 85 N

Torque = Transmitted force x Effective Radius

= 8893. 85 N x 0. 30 m

= 266. 79 N

Brake Caliper

The brake caliper, a key component of your car’s brake system, operates just like a small hydraulic clamp designed to grip the brake rotor and bring your car to a halt. If you've ever seen or worked on a brake caliper, you know what we're talking about. The brake caliper is a U-shaped device with a piston or pistons on one or both sides of the U. The brake pads ride on top of the brake caliper pistons, and the rotor spins in the channel of the U. When you hit the brakes, high-pressure fluid is channeled from the master cylinder down to the brake caliper where it pushes the piston or pistons inward. That brake caliper action moves the pads against the spinning brake rotor, and the friction stops your vehicle. Since the brake caliper is affixed to your vehicle frame and the rotor is spinning and hundreds of RPM, it's easy to imagine the massive forces that the brake caliper has to absorb. Much of the heat energy is dissipated by the rotor and pads which is why they're replaced the most, but the pulling and twisting forces the brake caliper has to endure require that it be extremely strong. More than anything else, though, it's the hydraulic brake fluid that leads to the demise of a brake caliper. If it's not changed often enough, moisture in the fluid will begin to rust out the inside of your brake caliper, resulting in leaks and sticking pistons. Eventually the brake caliper will cease to function altogether, it will effect your car's stopping ability.

Calipers

The brake caliper is the assembly which houses the brake pads and pistons. The pistons are usually made of aluminum or chrome plated iron There are two types of calipers: floating or fixed. A fixed caliper does not move relative to the disc. It uses one or more pairs of pistons to clamp from each side of the disc, and is more complex and expensive than a floating caliper. A floating caliper (also called a " sliding caliper") moves with respect to the disc; a piston on one side of the disc pushes the inner brake pad till it makes contact with the braking surface, then pulls the caliper body with the outer brake pad so pressure is applied to both sides of the disc.

Floating caliper (single piston) designs are subject to failure due to sticking. This can occur due to dirt or corrosion if the vehicle is not operated. This can cause the pad attached to the caliper to rub on the disk when the brake is released. This can reduce fuel mileage and cause excessive wear on the effected pad.

Brake caliper

In a vehicle the brake pedal in 360mm and the booster is connected 50mm from the pivot. The booster diaphragm is 220mm with the valve body of 52mm diameter the diaphragm return spring has a pretension force of 80N and rate of 12N/mm. The engine manifold pressure of 36Kpa and ambient pressure is 90Kpa. The master cylinder diameter is 26mm and return spring retention force is 15N and a rate of 8N/mm. the caster piston in 46mm and the co-efficient of friction between the 2 pads and the 250mm effective diameter disc are 0. 30. The wheel diameter is 625 mm. fluids the tractive braking forces if the driver applied force of 80N and his fast moves 46mm.

Data:

Force applied: 80N

Length of brake pedal: 340mm

Pedal movement: 46mm

Pivot of brake booster: 50mm

Diaphragm diameter: 220mm

Valve body diameter: 52mm

Spring rate: 80N

Pre-tension of diaphragm spring: 12N/m

Ambient pressure: 90kpa

Engine manifold pressure: 36kpa

Diameter of master cylinder: 26mm

Piston spring pretension: 15N

Piston spring rate: 8N/mm

Wheel diameter: 625mm

Efficient Disc diameter: 0. 30/ 250mm

Caliper piston: 46mm

Calculations with brake booster for 1 port caliper:

Pedal ratio = Length of pedal__

Pivot of brake booster

= 340mm_

50mm

=

Movement = _Pedal movement

Pedal ratio

= _46mm_

7. 2

= 6. 38

Diaphragm Pressure = Ambient pressure – Manifold pressure

= 90Kpa – 36Kpa

= 54Kpa

Diaphragm Area = Total area -Area of valve body

= 0. 25TT (220X10-3)2 – 0. 25TT (54X10-3) 2

= 35. 72 x 10-3

Force of Diaphragm = Pressure x Area

= 54Kpa x 10-3 x 35. 72 x 10-3

= 1928. 88 Nm

Booster output force=

Diaphragm force – (spring pre-tension + rate of spring x movement of piston)

= 1928. 88 Nm – (80N + 12N/m x 6. 83)

= 1928. 88 Nm – 156. 56

= 1772. 32 Nm

Driver applied force = Applied force x pedal ratio + Booster output

= 80N x 7. 2+ 1772. 32 Nm

= 2348. 32 N

Piston force =

Booster force – (Pretension force + Rate of spring x movement of piston)

= 2348. 32 N – (15N +8N/m x 6. 38)

= 2348. 32 N – 66. 04

= 2282. 28N

Pressure = ____Force___

Area of piston

= 2282. 28N

0. 25 TT D2

= 2282. 28N

0. 25TT (26 x 10-3)2

= 42986. 52 Pa or 4. 29 Mpa

Caliper force = Pressure x Area

= 42986. 52 Pa x 0. 25TT (46 X10-3)2

= 7143. 94N

Transmitted force = Caliper force x Co-efficient of friction x Number of pads

= 7143. 94N x 0. 35 x 2

= 5000. 758N

Torque = Transmitted force x Effective radius

= 5000. 758N x 0. 125m

= 625. 094Nm

Tractive = Torque (Braking)

Radius of wheel

= 625. 094Nm

0. 35m

= 1785. 985N

Difference between Tractive with & without brake booster

Tractive different = Tractive with brake booster – Tractive without brake booster

= 1785. 985N – 226. 79N

In the previous calculations it just goes to show you how useful the brake booster application is in today's modern vehicle, because if it wasn't we would have to apply a major amount of pressure to the brake pedal, the brake booster wasn't really put to its application till the early 1950's, but in this modern day and age there are more technical designs which involve a use of 2 and 4 pot calipers this design isn't just to make the brake system look better but it also increases the tractive braking force

The design of the brake discs and caliper varies. Some are simply solid steel and some are made up of carbon fibers, but others are hollowed out with fins joining together the disc's two contact surfaces usually included as part of a casting process. This ventilated disc design helps to dissipate the generated heat. Many motor bikes and sport car brakes instead have many small holes drilled through them for the same purpose. Additionally, the holes aid the pads in wiping water from the braking surface. Other designs include slots shallow channels machined into the disc to aid in removing used brake material from the brake pads. Slotted discs are generally not used on road cars because they quickly wear down brake pads. However this removal of material is beneficial to race cars since it keeps the pads soft and avoids verification of their surfaces. Some discs are both drilled and slotted.

Pistons & cylinders

The most common caliper design uses a single hydraulically actuated piston within a cylinder, although high performance brakes use as many as 8. Modern cars use different hydraulic circuits to actuate the brakes on each set of wheels as a safety measure. The hydraulic design also helps multiply braking force.

Failure can occur due to failure of the piston to retract – this is usually a consequence of not operating the vehicle during a time that it is stored outdoors in adverse conditions. For high mileage vehicles the piston seals may leak, which must be promptly corrected.

Parking brakes

Most vehicles include a mechanical parking brake system also called an emergency brake which operates on the rear wheels. These systems are very effective with drum brakes, since these tend to lock. The adoption of rear-wheel disc brakes caused concern that a disc-based parking brake would not effectively hold a vehicle on an incline.

Today, most cars use the disc for parking, though some still rely on separate drums.

An emergency brake is a braking system that is generally only to be used in emergency situations to slow or stop a machine. The most well known emergency brakes are those in trains and automotive vehicles. Many people shorten emergency and call the devices e-brakes. Additionally, in the automotive side, they are also known as parking brakes and hand brakes. In cars, the emergency brake is a supplementary system that can be used if the vehicle's primary brake system has a failure. Automobile e-brakes usually consist of a cable directly connected to the brake mechanism on one end and to some type of lever that can be actuated by the driver on the other end.

DATA:

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Length of brake pedal: 360mm

Pedal movement: 46mm

Pivot of brake booster: 50mm

Diaphragm diameter: 220mm

Valve body diameter: 52mm

Spring rate: 80 N

Pre tension of diaphragm spring: 12 N/m

Ambient pressure: 90kpa

Manifold pressure: 36kpa

Diameter of master cylinders: 26mm

Piston spring pretension: 15 N

Piston spring rate: 8 N/m

Wheel Diameter: 625mm

Efficient disc diameter: 0. 35 / 250mm

Calliper piston: 46mm x 2

Calculation with brake booster for two pot callipers:

Pedal ratio = Length of pedal

Pivot of brake booster

= 360mm

50mm

= 7. 2

Movement = Pedal movement

Pedal ratio

= 46mm

7. 2

= 6. 38

Diaphragm pressure = Ambient pressure – Manifold pressure

= 90Kpa – 36Kpa

= 54 Kpa

Diaphragm Area = Total area – Area of valve body

= 0. 25TT (220 x 10 -3) 2 -0. 25TT (54 x 10 -3) 2

= 35. 72 x 10 -3

Force of diaphragm = Pressure x Area

= 54 Kpa x10 -3 x 35. 72 x 10 -3

= 1928. 88 Nm

Booster output force = Diaphragm force – (spring pretension + rate of spring movement of piston)

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= 1928. 88 Nm – 156. 56

= 1772. 32 Nm

Driver s applied force = Applied force x pedal ratio + booster output

= 80 N x 6. 38+ 1772. 32 Nm

= 2348. 32

Piston force = Booster force – (pretension force = rate of spring x movement of piston)

= 2348. 32- (15N + 8 N/m x 6. 38)

= 2348. 32- 66. 04

= 2282. 28N

Pressure = Force

Area of piston

= 2282. 28N

0. 25TT D2

= 2282. 28N

0. 25TT (26 x 10-3)2

= 42986. 52 Pa or 4. 29mpa

Caliper force = Pressure x area x number of pistons

= 42986. 52 Pa x 0. 25TT (46 x 10 – 3)2 x 2

= 14287. 88 N

Transmitted force = Caliper Force x Co – efficient of friction x number of pads

= 14287. 88 N x 0. 35 x 2

= 10001. 51 N

Torque = Transmitted force x Effective radius

= 10001. 51 N x 0. 125 m

= 1250. 18 Nm

Tractive = Torque

Radius of wheel

= 1250. 18 Nm

0. 35m

= 3571. 97N

Tractive = Tractive for 2 pot caliper – tractive for 1 pot caliper

= 3571. 97N – 1785. 985N

= 1785. 985N

My thoughts

After going through and researching all types of brake’s and what there application is in today’s modern motor vehicles, it showed that there are many uses for different types of brakes, especially when you’re driving in different situations and environments, e. g. When driving in the city, you tend to use more of the braking system and when driving in the country you need heavy duty pads.

It is essential that we know how the brakes work, and it is important to use the right type of brake pads for each different driving application. Some brakes work well once they are heated up and some work well in the colder conditions.

So when we go get our brake pads changed its up to the mechanic to make that call to see what pads should be used for the correct braking situation. This will save damage to the brake disc and stop it from causing further damage to anything else.

My concept is to some how get a recording device or some type of sensor that has a memory in which it recalls everything that you have done in regards to the braking system and the brake pads. This will keep a record of your amount of braking you have done and also what type of conditions you have been driving in. So this could tell you that you have been driving in a cold area but doing lots of braking , so when it come to changing these pads you could just unplug the sensor and check and make your own decision upon the type of pads that will suit to your braking application.

Advantages of this concept are:

The temperature will always be monitored

You know exactly when you need to change you brake pads

You know how much you are actually using the braking system

You know exactly which brake pad is suited for the application

No problems of over heating

You know if there are any problems in regards to damage of brakes or discs