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Design and Static Analysis of Drum Brake with Different Materials

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ABSTRACT

*A brake is a mechanical device which in habits motion. A **drum brake** is a brake that uses friction caused by a set of shoes or pads that press against a rotating drum-shaped part called a brake drum. The brake drum is a critical component that experiences high temperatures and develop thermal stresses during application of brakes. In addition, the application of shoe pressure gives rise to mechanical loads. Brakes in cars and trucks are safety parts. Requirements not only in performance but also in comfort, serviceability and working lifetime are high and rising. i.e.*

The Brake Drum with the friction material, the counter body and caliper, can be modelled. So in this project we design the model of drum brake(drum, & pads) in catia v5 and structural analysis is performed in ansys workbench software to find the total deformation and stress of the drum break with some materials .

INTRODUCTION

A brake is a device which is used to bring to rest or slow down a moving body. Safe operation of vehicle demands dependable brakes is required to absorb the kinetic energy of the moving parts or the potential energy of the object being lowered by host when the rate of descent is controlled. The energy absorbed by brakes is dissipated in the form of heat. This heat is dissipated in the surrounding atmosphere to stop the vehicle, so the brake system should have following

requirements:

- The brakes must be strong enough to stop the vehicle with in a minimum distance in an emergency.
- The driver must have proper control over the vehicle during braking and vehicle must not skid.
- The brakes must have well anti fade characteristics i.e. their effectiveness should not

decrease with is constant prolonged application.

- The brakes should have well anti wear properties. The important requirements of the brake drum are following:
- It should provide a surface having well anti wear qualities.
- It should allow the optimum rate of heat transfer.
- Heat is generated during each brake application and it must be dissipated to the atmosphere immediately, because the next brake application would again produce more heat. Any excess heating of brakes would cause the drum to expand resulting in loss ofeffective pedal travel and fading of brake lining.
- It should have sufficient strength but minimum weight.
- It should be able to be accommodated within the wheel space available.

LITERATURE SURVEY

Allan Michael Lang [1] in his research concluded that no simple relationship exists between the naturalfrequencies of the brake components and the squeal frequency and during squeal both the drum and shoes hold complex modes, which can be best visualized as the superposition of pairs of similar normal modes phase shifted both spatially and in time relative to each other.

Mohd Zald bin Akop [2] in his project concluded that safety aspect in automotive engineering has been considered as a number one priority in development of new vehicle and it is a must for all vehicles to have proper brake system.

Ramesha.D.K et al [3] in his thesis concluded that the maximum temperature obtained for aluminum alloy brake drum is less as compared to the cast iron brakedrum for a truck. Also, concluded that thermal deformation is less for aluminum alloy brake drum than the cast iron brake drum. As his study states that the weight of Aluminum is lesser than the Cast iron, it is better to use the Aluminum material in the construction of brake drum.

NurulhudaBinti Khalid [4] In his project concluded that the temperature changes on the brake drum during the deceleration providing the heat distribution and the distribution of temperature depends on the various factors such as friction, surface roughness, speed, and others.

PROBLEM STATEMENT

Drum Brake and Drum Brake Pad are connected on the wheels of automobile for the braking of the

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vehicle on road. The drum brake and brake pad under goes several rough conditions on road different types of loads and temperatures will be acting on the brakes. The brakes are surely essential for the effective stopping of the vehicle. Here in this project we are taking the load condition as 1.5Mpa pressure on the face of the drum Brake and also the Drum brake pad. We are using three different materials i.e aluminium alloy, carbon steel and aluminium metal matrix composite. Doing the analysis on three different materials using the load condition we will find which is the best appropriate material for use. Also when the brake is applied due to the friction between the drum and the brake pad certain heat is distributed and released. Here we consider the thermal conditions to be as 90deg temperature and 22deg convection. Thus applying all the load and thermal conditions for three different materials Drum Brake and BrakePad we conclude the best desirable materials.

Drum Brake

A **drum brake** is a brake that uses friction caused by a set of shoes or pads that press outward against a rotating cylinder-shaped part called a brake drum.

The term drum brake usually means a brake in which shoes press on the inner surface of the drum. When shoes press on the outside of the drum, it is usually called a clasp brake. Where the drum is pinched between two shoes, similar to a conventional disc brake, it is sometimes called a pinch drum brake, though such brakes are relatively rare. A related type called a band brakeuses a flexible belt or "band" wrapping around the outside of a drum.

Drum brake with the drum removed, on the rear of Chevrolet pickup truck

A rear drum brake on a Kawasaki W800 motorcycle

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Components

Backing plate

The backing plate provides a base for the other components. The back plate also increases the rigidity of whole set-up, supports the housing, and protects it from foreign materials like dust and other road debris. It absorbs the torque from the braking action, and that is why back plate is also called the "Torque Plate". Since all braking operations exert pressure on the backing plate, it must be strong and wear-resistant. Levers for emergency or parking brakes, and automatic brake-shoe adjuster were also added in recent years.

Back plate made in the pressing shop.

Brake drum

The brake drum is generally made of a special type of cast iron that is heat-conductive and wear-resistant. It rotates with the wheel and axle. When a driver applies the brakes, the lining pushes radially against the inner surface of the drum, and the ensuing friction slows or stops rotation of the wheel and axle, and thus the vehicle. This friction generates substantial heat.

Wheel cylinder

Cut-away section of a wheel cylinder.

One-wheel cylinder operates the brake on each wheel. Two pistons operate the shoes, one at each end of the wheel cylinder. The leading shoe (closest to the front of the vehicle) is known as the primary shoe. The trailing shoe is known as the secondary shoe. Hydraulic pressure from the master cylinder acts on the piston cup, pushing the pistons toward the shoes, forcing them against the drum. When the driver releases the brakes, the brake shoe springs restore the shoes to their original (disengaged) position. The parts of the wheel cylinder are shown to the right.

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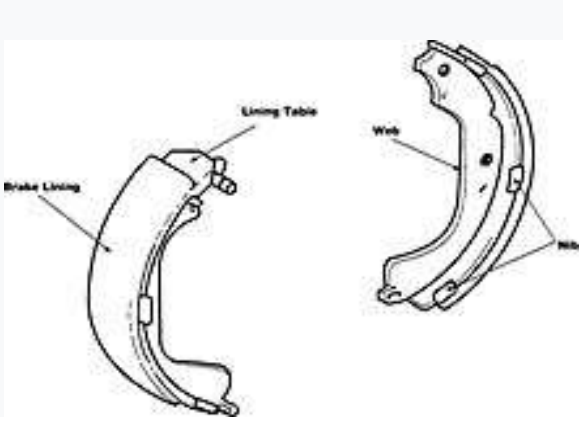
Brake shoe assembly

Brake shoe

Brake shoes are typically made of two pieces of steel welded together. The friction material is either riveted to the lining table or attached with adhesive. The crescent-shaped piece is called the Web and contains holes and slots in different shapes for return springs, hold-down hardware, parking brake linkage and self-adjusting components. All the application force of the wheel cylinder is applied through the web to the lining table and brake lining. The edge of the lining table generally has three "V"-shaped notches or tabs on each side called nibs. The nibs rest against the support pads of the backing plate to which the shoes are installed. Each brake assembly has two shoes, a primary and secondary. The primary shoe is located toward the front of the vehicle and has the lining positioned differently from the secondary shoe. Quite often, the two shoes are interchangeable, so close inspection for any variation is important.



Linings must be resistant to heat and wear and have a high friction coefficient unaffected by fluctuations in temperature and humidity. Materials that make up the brake shoe include, friction modifiers (which can include graphite and cashew nut shells), powdered metal such as lead, zinc, brass, aluminium and other metals that resist heat fade, binders, curing agents and fillers such as rubber chips to reduce brake noise.

In the UK two common grades of brake shoe material used to be available. DON 202 was a high friction material that did not require a brake power servo. The disadvantage was that the lining was prone to fading on steep hills (calculate the kilowatts dissipated by a one-ton car descending a 15% hill at a constant 60 mph) A harder lining, the famous VG95 was produced but this required a brake servo. The other snag was that the parking brake would often fail the annual MOT test unless the high friction linings were installed just for the test.

Drum Brake Design

Rear drum brakes are typically of a leading/trailing design (for non-servo systems), or primary/secondary (for duo servo systems) the shoes being moved by a

single double-acting hydraulic cylinder and hinged at the same point.[5] In this design, one of the brake shoes always experiences the self-applying effect, irrespective of whether the vehicle is moving forwards or backwards.[5] This is particularly useful on the rear brakes, where the parking brake (handbrake or footbrake) must exert enough force to stop the vehicle from traveling backwards and hold it on a slope. Provided the contact area of the brake shoes is large enough, which isn't always the case, the self-applying effect can securely hold a vehicle when the weight is transferred to the rear brakes due to the incline of a slope or the reverse direction of motion. A further advantage of using a single hydraulic cylinder on the rear is that the opposite pivot may be made in the form of a double-lobed camthat is rotated by the action of the parking brake system.

Rendering of a drum brake

Advantages and Disadvantages

Drum brakes, use a set of brake shoes that expand outward against the inside of the rotating brake drum. Hydraulic pressure acts on the pistons in the wheel cylinder, which then presses the shoes outward. When the brake pedal is released, return springs pull the shoes back to their rest position. An advantage of drum brakes compared to disc brakes is that when the brakes are applied, the force of the rotating drum can be used to force the forward (primary) shoe as a lever against the rear (secondary) shoe, increasing the amount of brake application force. This allows the drum brake to achieve greater stopping force than is supplied just by the driver pushing on the brake pedal. Because of this advantage, vehicles with four-wheel drum brakes do not require a power-assisted brake system like those using disc brakes do. The disadvantages of drum brakes include mechanical brake fade as the drum expands from heat generation, poor heat dissipation compared to disc brakes, dust buildup within the drum that often causes brake noise, and the need for a self-adjusting system to maintain shoe-to-drum clearance and correct brake pedal height.

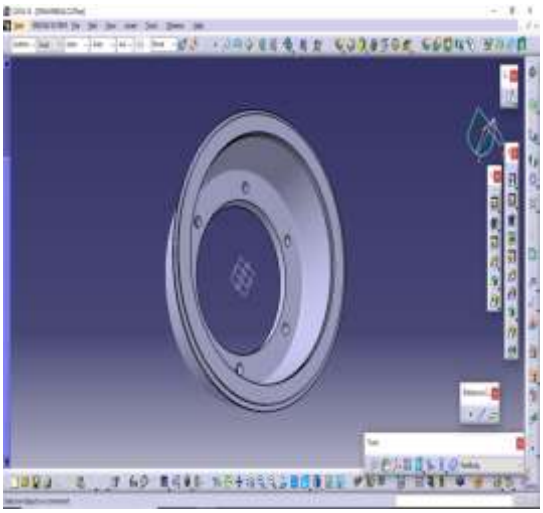
Components

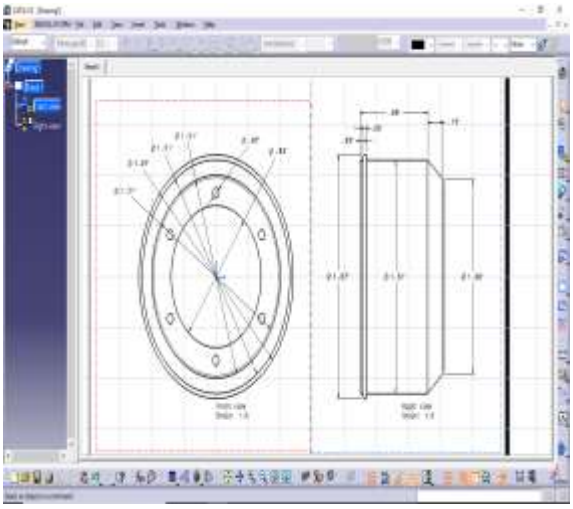
Most modern drum brake systems use the following components.

- Backing plate—
- Brake shoes—
- Brake drum
- Return springs

- Hold down springs and pins
- Wheel cylinder
- Self-adjuster assembly
- Anchor

CATIA 3D MODEL

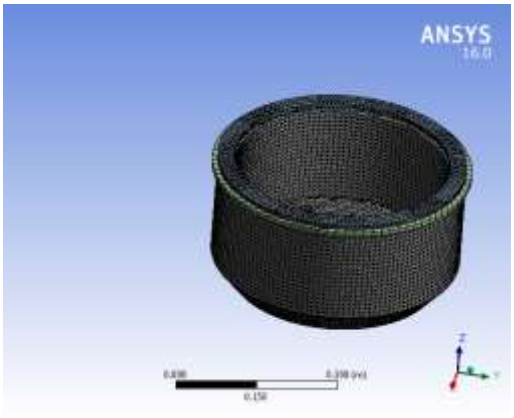




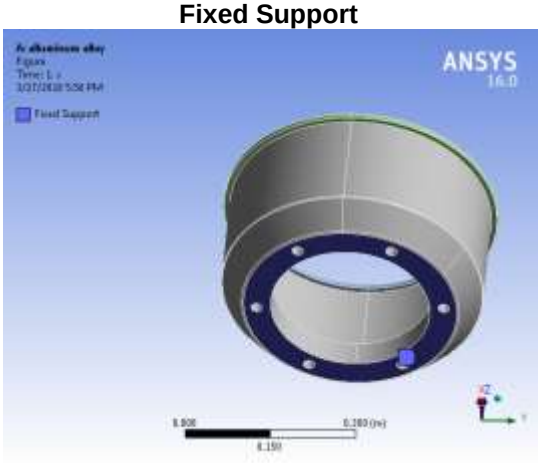
ANSYS RESULTS

- Static Structural (A5)

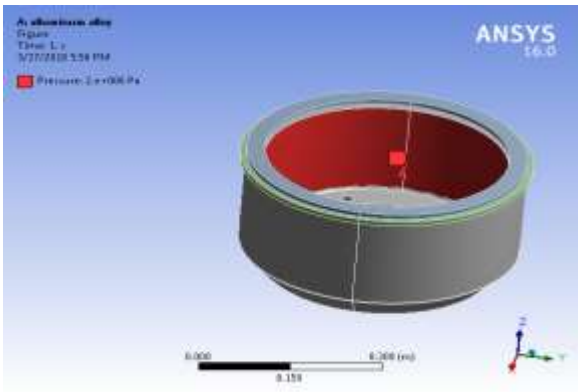
- Material Data
  - Aluminum Alloy
- Meshing



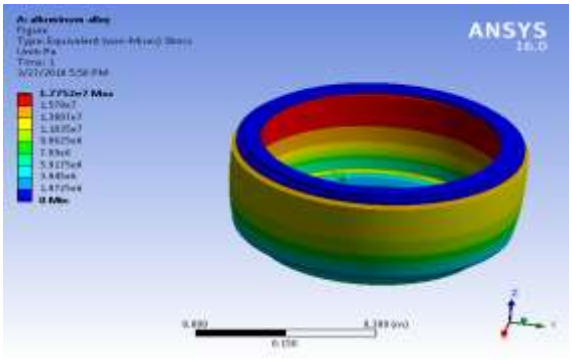
Fixed Support

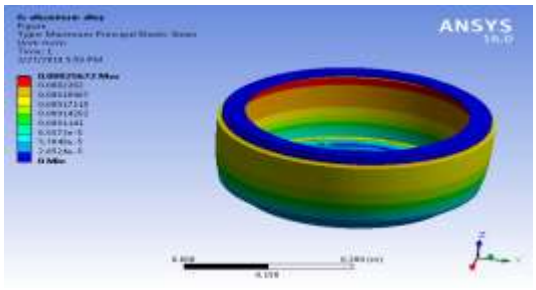


Pressure

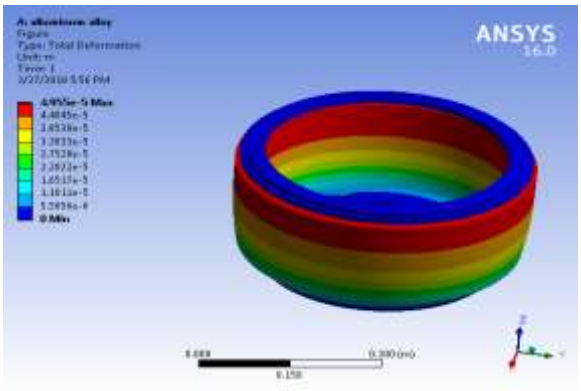


Equivalent Stress





Total Deformation



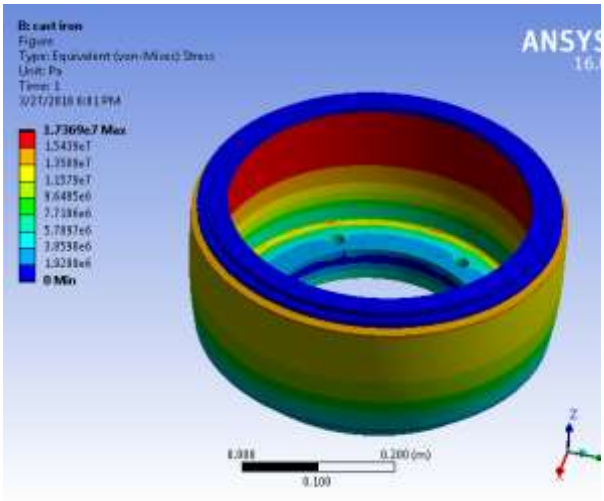
STATIC STRUCTURAL 2ND MATERIA

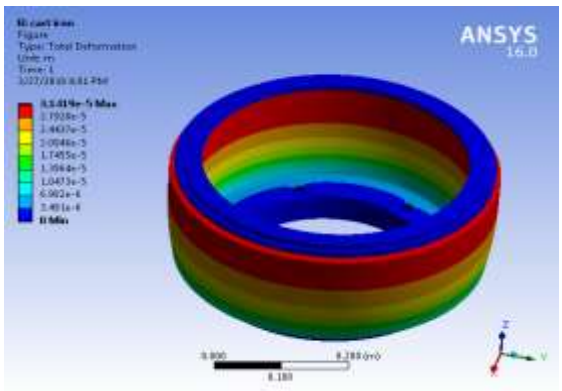
- **Maximum Principal Elastic Strain**

Gray Cast Iron

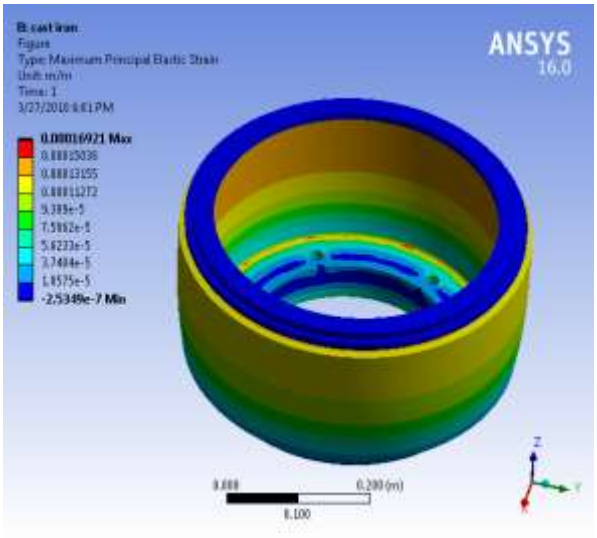
- Equvalent Stress

Total deformation





Maximum Principal Elastic Strain



Result table:

Material	stress	deformation
Aluminium alloy	1.7752e7	4.955e-5
Cast iron	1.7369e7	3.1419e-5

Conclusion:

The Brake Drum with the friction material, the counter body and caliper, can bemodeled.So in this project we design the model of drum brake(drum, & pads) in catia v5 and structuralanalysis isperformed in ansys workbench software, to find out strength of the materials of Drum brake

According to the above comparison of two materials aluminium and cast iron, the aluminium is the more strength compare to the cast iron, so we preferred aluminium is suitable material to drum brake & second choice to choose cast iron material to the drum brake.

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