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Design and Analysis of Disk Brake

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ABSTRACT:

One of the first steps taken to improve braking came in the early '70s when manufacturers, on a widespread scale, switched from drum to disc brakes.

Since most a vehicle's stopping power is contained in the front wheels, only the front brakes were upgraded to disc during much of this period. Since then, many manufacturers have adopted four-wheel disc brakes on their high-end and performance models as well as their low-line economy cars.This project is done by creating a tri dimensional model (model name) and this model is generated by using design software CATIA. CATIA is useful for designing different number of models as per the dimensions, as it is a versatile application. The model should be analyzed and measured which is designed in CATIA. The obtained model is taken and geometric views are generated and following screenshots are shown. Analysis of the design is obtained by using Ansys software and following results and tables are listed in this project.

INTRODUCTION

1.1 DISK BRAKE

Ever since the invention of the wheel, if there has been "go" there has been a need for "whoa." As the level of technology of human transportation has increased, the mechanical devices used to slow down and stop vehicles has also become more complex. In this report I will discuss the history of vehicular braking technology and possible future developments. Before there was a "horse-less carriage," wagons, and other animal drawn vehicles relied on the animal's power to both accelerate and decelerate the vehicle. Eventually there was the development of supplemental braking systems consisting of a hand lever to push a wooden friction pad directly against the metal tread of the wheels. In wet conditions these crude brakes would lose any effectiveness.

1.2 HOW BRAKES WORK

We all know that pushing down on the brake pedal slows a car to a stop. But how does this happen? How does your car transmit the force from your leg to its wheels? How does it multiply the force so that it is enough to stop something as big as a car?

1.3 BRAKE BASICS

When you depress your brake pedal, your car transmits the force from your foot to its brakes through a fluid. Since the actual brakes require a much greater force than you could apply with your leg, your car must also multiply the force of your foot. It does this in two ways:

- Mechanical advantage(leverage)
- Hydraulic force multiplication

1.4 LEVERAGE

The pedal is designed in such a way that it can multiply the force from your leg several times before any force is even transmitted to the brake fluid.

1.5 HYDRAULIC SYSTEMS

The basic idea behind any hydraulic system is very simple: Force applied at one point is transmitted to another point using an **incompressible fluid**, almost always an oil of some sort. Most brake systems also multiply the force in the process

1.6 FRICTION

Friction is a measure of how hard it is to slide one object over another. Take a look at the figure below. Both of the blocks are made from the same material,

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but one is heavier. I think we all know which one will be harder for the bulldozer to push.

1.7 A SIMPLE BRAKE SYSTEM

The distance from the pedal to the pivot is four times the distance from the cylinder to the pivot, so the force at the pedal will be increased by a factor of four before it is transmitted to the cylinder.

The diameter of the brake cylinder is three times the diameter of the pedal cylinder. This further multiplies the force by nine. All together, this system increases the force of your foot by a factor of 36. If you put 10 pounds of force on the pedal, 360 pounds (162 kg) will be generated at the wheel squeezing the brake pads.

1.8 TYPES OF BRAKES

1. DRUM BRAKES
2. DISC BRAKES (CALLIPER BRAKES)

1.9 DRUM BRAKES:

The drum brake has two brake shoes and a piston. When you hit the brake pedal, the piston pushes the brake shoes against the drum This is where it gets a little more complicated. as the brake shoes contact the drum, there is a kind of wedging action, which has the effect of pressing the shoes into the drum with more force. The extra braking force provided by the wedging action allows drum brakes to use a smaller piston than disc brakes. But, because of the wedging action, the shoes must be pulled away from the drum when the brakes are released. This is the reason for some of the springs. Other springs help hold the brake shoes in place and return the adjuster arm after it actuates.

1.10 DISK BRAKE BASICS:

The disk brake has a metal disk instead of a drum. It has a flat shoe, or pad, located on each side of the disk. To slow or stop the car, these two flat shoes are forced tightly against the rotating disk, or rotor. Fluid pressure from the master cylinder forces the pistons to move in. This action pushes the friction pads of the shoes tightly against the disk. The friction between the shoes and the disk slows and stops the disk.

1.11 TYPES OF DISK BRAKES

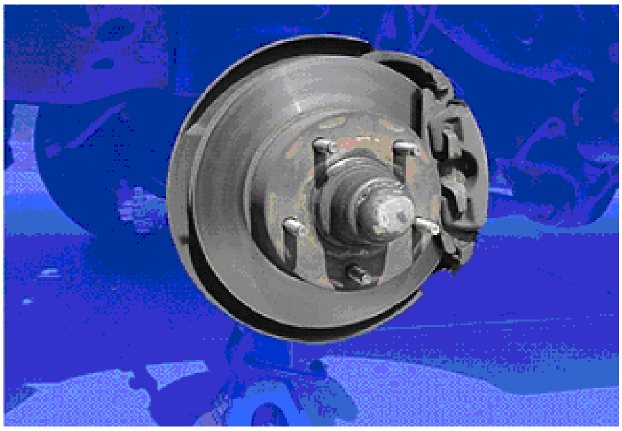
The Three Types Of Disk Brakes Are:
1. FLOATING CALIPER DISK BRAKES
2. FIXED CALIPER DISK BRAKES
3. SLIDING CALIPER DISK CALIPER

1.12 MAIN PARTS:

The main components of a disc brake are:

- The brake pads
- The caliper, which contains a piston
- The rotor, which is mounted to the hub

1.13 BRAKE PAD



CALIPER AND ROTO

1.14 WORKING OF DISC BRAKES

The caliper is the part that holds the break shoes on each side of the disk. In the floating-caliper brake, two steel guide pins are threaded into the steering-knuckle adapter. The caliper floats on four rubber bushings which fit on the inner and outer ends of the two guide pins. The bushings allow the caliper to swing in or out slightly when the brakes are applied

1.15 FIXED-CALIPER DISK BRAKE

This brake usually has four pistons, two on each side of the disk. The reason for the name fixed-caliperis that the caliper is bolted solidly to the steering knuckle. When the brakes are applied, the caliper

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cannot move. The four pistons are forced out of their caliper bores to push the inner and outer brake shoes in against the disk. Some brakes of this type have used only two pistons, one on each side of the disk

1.16 LIDING-CALIPER DISK BRAKE

The sliding-caliper disk brake is similar to the floating-caliper disk brake. The difference is that sliding-caliper is suspended from rubber bushings on bolts. This permits the caliper to slide on the bolts when the brakes are applied.

1.17 SELF ADJUSTMENT OF DISK BRAKES:

Disk brakes are self-adjusting. Each piston has a seal on it to prevent fluid leakage. When the brakes are applied, the piston moves toward the disk. This distorts the piston seal. When the brakes are released, the seal relaxes and returns to its original position. This pulls the piston away from the disk. As the brakes linings wear, the piston over travels and takes a new position in relation to the seal. This action provides self-adjustment of disk brakes.

1.18 EMERGENCY BRAKES

In cars with disc brakes on all four wheels, an emergency brake has to be actuated by a separate mechanism than the primary brakes in case of a total primary brake failure. Most cars see a cable to actuate the emergency brake.

Some cars with four-wheel disc brakes have a separate drum brake integrated into the hub of the rear wheels. This drum brake is only for the emergency brake system, and it is actuated only by the cable; it has no hydraulics.

1.19 BRAKE FADE

Vehicle braking systemfade, or brakefade, is the reduction in stopping power that can occur after repeated or sustained application of the brakes, especially in high load or high speed conditions. Brake fade can be a factor in any vehicle that utilizes a friction braking system including automobiles, trucks, motorcycles, airplanes, and even bicycles.

Brake fade is caused by a buildup of heat in the braking surfaces and the subsequent changes and reactions in the brake system components and can be experienced with both drum brakes and discbrakes. Loss of stopping power, or fade, can be caused by friction fade, mechanical fade, or fluid fade

1.20 BRAKE MODIFICATION TO REDUCE FAD

High performance brake components provide enhanced stopping power by improving friction while reducing brake fade. Improved friction is provided by lining materials that have a higher coefficient of friction than standard brake pads, while brake fade is reduced through the use of more expensive binding resins with a higher melting point, along with slotted, drilled, or dimpled discs/rotors that reduce the gaseous boundary layer, in addition to providing enhanced heat dissipation. Heat buildup in brakes can be further addressed by body modifications that direct cold air to the brakes.

1.21 DISK BRAKE VENTS

A moving car has a certain amount of kinetic energy, and the brakes have to remove this energy from the car in order to stop it. How do the brakes do this? Each time you stop your car, your brakes convert the kinetic energy to heat generated by the friction between the pads and the disc. Most car disc brakes are vented.

Brake fade caused by overheating brake fluid (often called Pedal Fade) can also be reduced through the use of thermal barriers that are placed between the brake pad and the brake caliper piston, these reduce the transfer of heat from the pad to the caliper and in turn hydraulic brake fluid. Some high-performance racing calipers already include such brake heat shields made from titanium or ceramic materials. However, it is also possible to purchase aftermarket titanium brake heat shields [6] that will fit your existing brake system to

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provide protection from brake heat. These inserts are precision cut to cover as much of the pad as possible

1.22 ADVANTAGES OF DISC BRAKES OVER DRUM BRAKES

As with almost any artifact of technology, drum brakes and disk brakes both have advantages and disadvantages. Drum brakes still have the edge in cheaper cost and lower complexity. This is why most cars built today use disk brakes in front but drum brakes in the back wheels, four wheel disks being an extra cost option or shouted as a high performance feature. Since the weight shift of a decelerating car puts most of the load on the front wheels, the usage of disk brakes on only the front wheels is accepted manufacturing practice.

Drum brakes had another advantage compared to early disk brake systems. The geometry of the brake shoes inside the drums can be designed for a mechanical self-boosting action. The rotation of the brake drum will push a leading shoe brake pad into pressing harder against the drum. Early disk brake systems required an outside mechanical brake booster such as a vacuum assist or hydraulic pump to generate the pressure for primitive friction materials to apply the necessary braking force.

Why are disk brakes more efficient :

- Flat brake disk (axial brake) under high pressure versus round brake drum (radial brake) during braking
- Full friction surface of the brake pad on the plane brake disk.
- No loss of brake power due to overheating or partial contact from brake drum parts expansion.

Why do disk brakes have a better braking behavior

- Driver friendly braking behavior. Sensitive braking in all situations and better
- Sensitive brake application and better brake feeling
- Uniform braking from small fluctuations in brake forces
- Retardation values retained even under heavy stresses

Why do disk brakes have higher safety reserves?

- Minimal braking effect from high temperatures and extreme driving requirements Minimal heat fading
- No brake disk distortion from extreme heat due to internal ventilation with directional stability and large power reserve under high stress
- The decisive safety aspects of the disk brake design are shorter braking distances

TESTING OF DISK BRAKES

The individual components are subjected to extensive test on the test bed. The optimum arrangement of components on the axle beam, operational reliability and convincing performance are requirements that must be met prior series production.

2.1 Introduction To CAD/CAM/CAE

The Modern world of design, development, manufacturing so on, in which we have stepped can't be imagined without interference of computer. The usage of computer is such that, they have become an integral part of these fields. In the world market now the competition in not only cost factor but also quality, consistency, availability, packing, stocking, delivery etc. So are the requirements forcing industries to adopt modern technique rather than local forcing the industries to adapt better techniques like CAD / CAM / CAE, etc.

2.2 Need for CAD/CAE &CAM

The usage of CAD CAE & CAM have changed the over look of the industries and developed healthy & standard competition , as could achieve target in lean time and ultimately the product reaches market in estimated time with better quality and consistency . In

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general view, it has lead to fast approach and creative thinking.

2.3 Introduction to CATIA

CATIA is a robust application that enables you to create rich and complex designs. The goals of the CATIA course are to teach you how to build parts and assemblies in CATIA, and how to make simple drawings of those parts and assemblies. This course focuses on the fundamental skills and concepts that enable you to create a solid foundation for your designs

2.5 Feature-based

Like an assembly is made up of a number of individual parts, a CATIA document is made up of individual elements. These elements are called features.

When creating a document, you can add features such as pads, pockets, holes, ribs, fillets, chamfers, and drafts. As the features are created, they are applied directly to the work piece.

2.6 Parametric

The dimensions and relations used to create a feature are stored in the model. This enables you to capture design intent, and to easily make changes to the model through these parameters.

2.7 Solid Modeling

3A solid model is the most complete type of geometric model used in CAD systems. It contains a.7ll the wireframe and surface geometry necessary to fully describe the edges and faces of the model. In addition to geometric information, solid models also convey their topology, which relates the geometry together. For example, topology might include identifying which faces (surfaces) meet at which edges (curves).

This intelligence makes adding features easier. For example, if a model requires a fillet, you simply select an edge and specify a radius to create it.

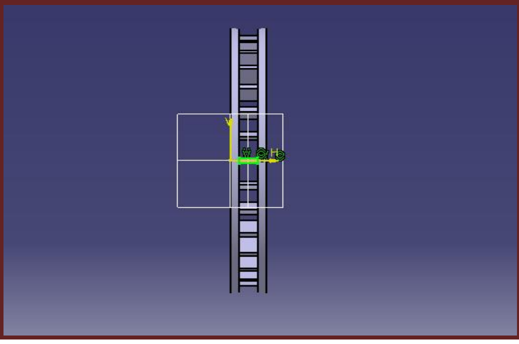
2.8 Fully Associative:

A CATIA model is fully associative with the drawings and parts or assemblies that reference it. Changes to the model are automatically reflected in the associated drawings, parts, and/or assemblies. Likewise, changes in the context of the drawing or assembly are reflected back in the model.

3. DESING ANALYSIS TO DEVELOP THE WORK

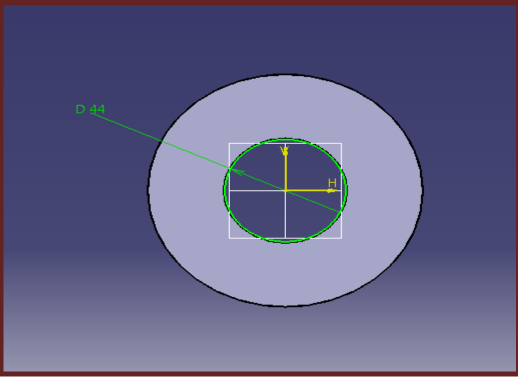
Cylindrical Line

Figure: 3.5



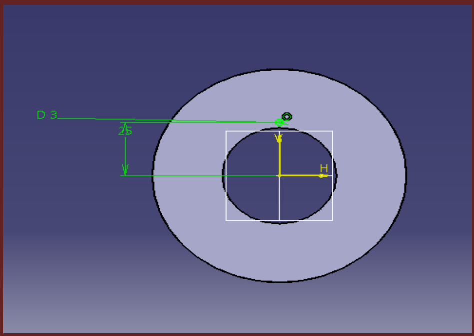
Sketure Top View

Figure: 3.6



Brake Hole of Top View

Figure: 3. 7



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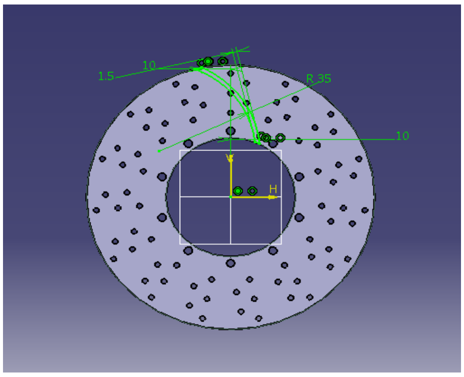
Hole in Pad

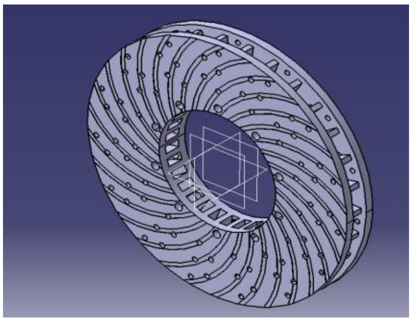
Figure: 3.8



No. of Holes in Top View

Figure: 3.10

Figure: 3.11



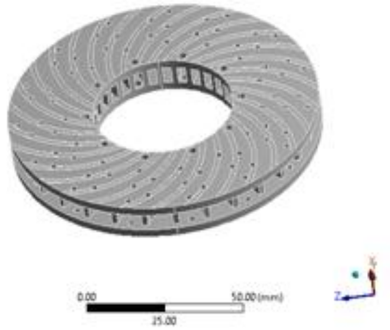
ANALYSIS:

Introduction:

This Tutorial wills use area by made file to speed up the learning process for the student. This file is provided in Para solid format. The intention of this tutorial is to get the student to run a straight forward simulation. By the end of this tutorial a check list for the required procedure can be formulated by the student. ANSYS as a software is made to be user-friendly and simplified as much as possible with lot so finter face options to keep the user as much as possible from the hectic side of programming and debugging process.

Why it is that such a simple model is used

During this tutorial as simple geometry is used, the objective of that is that the student masters the steps to get to run a simple simulation, once that's do ne the student can model any kind of geometry he sees necessary for his studied case.



Model (B4) > Steady-State Thermal (B5) > Solution (B6) > Temperature > Figure

5. RESULT

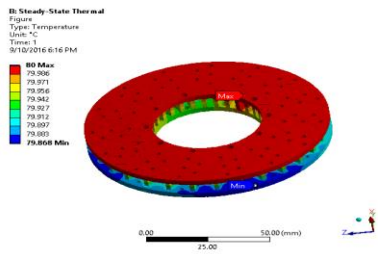
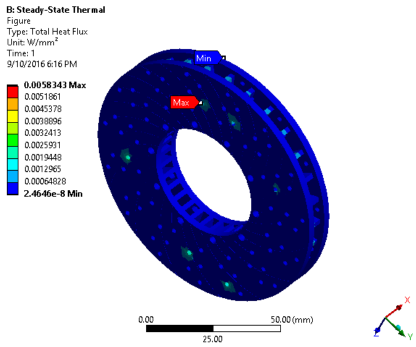


FIGURE 2



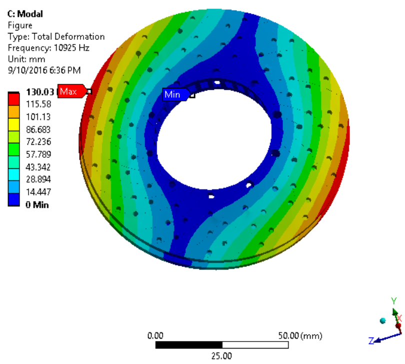


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TABLE 15

	Maximum value	Minimum value
Temperature	80c	79.868c
Total heat flux	5.8343e	2.4646e

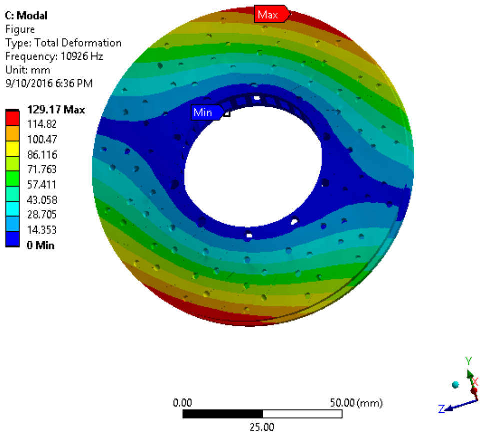
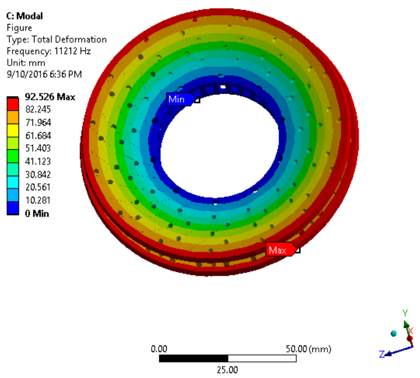
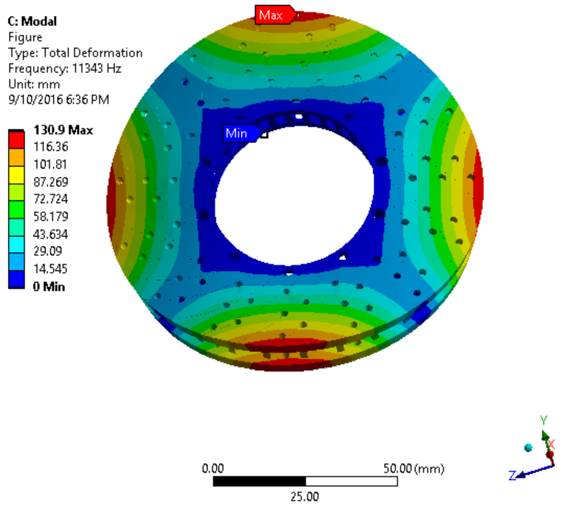


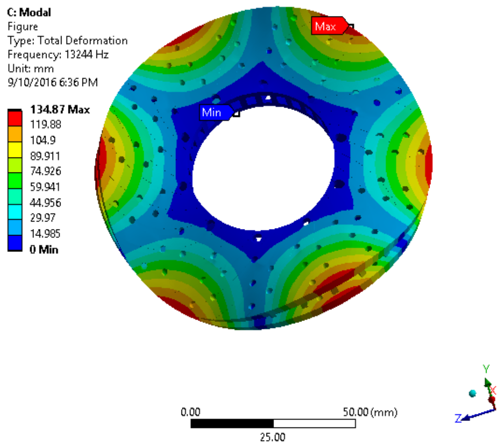
TABLE 17

	Maximum value	Minimum value
Temperature	80c	79.868c
Total heat flux	5.8343e	2.4646e
Total deformation	129.17	0
stress	3999Mpa	214Mpa



Model (C4) > Modal (C5) > Solution (C6) > Total Deformation 4





6. CONCLUSION

Many trucks and buses are equipped with air actuated sliding caliper disk brakes

The high contact forces are transmitted mechanically via needle mounted actuating device Depending on size the actuating pressure is transmitted evenly to the brake pads via one or two plungers.

The easy action, fully sealed guides between the axially moving sliding caliper and fixed brake anchor plate are maintenance free. Integrated automatic adjustment with wear display. There are no brake

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shafts, external levers, or cylinder brackets, as the brake cylinders are directly attached.

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