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Design and Analysis of Automobile Disc Brake Using Fea Tools

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CHAPTER – I

INTRODUCTION

A disc brake is a type of brake that uses calipers to squeeze pairs of pads against a disc or "rotor" to create friction. This action retards the rotation of a shaft, such as a vehivle axle, either to reduce its rotational speed or to hold it stationary. The energy of motion is converted into waste heat which must be dispersed.

Hydraulically actuated disc brakes are the most commonly used form of brake for motor vehicles, but the principles of a disc brake are applicable to almost any rotating shaft

Development of disc-type brakes began in England in the 1890s. In 1902, the Lanchester Motor Company designed brakes that looked and operated in a similar way to a modern disc-brake system even though the disc was thin and a cable activated the brake pad. Other designs were not practical or widely available in cars for another 60 years. Successful application began in airplanes before World War II, and even the German tiger tank was fitted with discs in 1942. After the war, technological progress began to arrive in the 1950s, leading to a critical demonstration of superiority , which required braking from high speeds several times per lap. The jaguar racing team won, using disc brake equipped cars, with much of the credit being given to the brakes' superior

performance over rivals equipped with druam breaks. Mass production began with the 1955citroenMost drum brake designs have at least one leading shoe, which gives a servo effect. By contrast, a disc brake has no self-servo effect and its braking force is always proportional to the pressure placed on the brake pad by the braking system via any brake servo, braking pedal, or lever. This tends to give the driver better "feel" and helps to avoid impending lockup. Drums are also prone to "bell mouthing" and trap worn lining material within the assembly, both causes of various braking problems.

CHAPTER – II

DESCRIPTION OF PROJECT

Brake caliper

The brake caliper is the assembly which houses the brake pads and pistons. The pistons are usually made of plastic, aluminum or chrome .

Calipers are of two types, floating or fixed. A fixed caliper does not move relative to the disc and is thus less tolerant of disc imperfections. It uses one or more pairs of opposing pistons to clamp from each side of the disc, and is more complex and expensive than a floating caliper. inner brake pad until 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 sticking failure, caused by dirt or corrosion entering at least one mounting mechanism and stopping its normal movement. This can lead to the caliper's pads rubbing on the disc when the brake is not engaged or engaging it at an angle. Sticking can result from infrequent vehicle use, failure of a seal or rubber protection boot allowing debris entry, dry-out of the grease in the mounting mechanism and subsequent moisture incursion leading to corrosion, or some combination of these factors. Consequences may include reduced fuel efficiency, extreme heating of the disc or excessive wear on the affected pad. A sticking front caliper may also cause steering vibration.

Another type of floating caliper is a swinging caliper. Instead of a pair of horizontal bolts that allow the caliper to move straight in and out respective to the car body, a swinging caliper utilizes a single, vertical pivot bolt located somewhere behind the axle centerline. When the driver presses the brakes, the brake piston pushes on the inside piston and rotates the whole caliper inward, when viewed from the top. Because the swinging caliper's piston angle changes relative to the disc, this design uses wedge-shaped pads that are narrower in the rear on the outside and narrower on the front on the inside.

Pistons and cylinders

The most common caliper design uses a single hydraulically actuated piston within a cylinder, although high performance breaks use as many as twelve. 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. The number of pistons in a caliper is often referred to as the number of 'pots', so if a vehicle has 'six pot' calipers it means that each caliper houses six pistons

CHAPTER – III
WORKING MECHANISM AND CALCULATION

Normal braking

The disc brake is a lot like the brakes on a bicycle. Bicycle brakes have a caliper, which squeezes the brake pads against the wheel. In a disc brake, the brake pads squeeze the rotor instead of the wheel, and the force is transmitted hydraulically instead of through a cable.Friction between the pads and the disc slows the disc down.

Automatic self-adjustment

The single-piston floating-caliper disc brake is self-centering and self-adjusting. The caliper is able to slide from side to side so it will move to the center each time the brakes are applied. Also, since there is no spring to pull the pads away from the disc, the pads always stay in light contact with the rotor (the rubber piston seal and any wobble in the rotor may actually pull the pads a small distance away from the rotor). This is important because the pistons in the breaks are much larger in diameter than the ones in the cylinder master. If the brake pistons retracted into their cylinders, it might take several applications of the brake pedal to pump enough fluid into the brake cylinder to engage the brake pads.

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 use a cable to actuate the emergency brake.

Servicing Your Brakes

The most common type of service required for brakes is changing the pads. Disc brake pads usually have a piece of metal on them called a wear indicator.

When enough of the friction material is worn away, the wear indicator will contact the disc and make a squealing sound. This means it is time for new brake pads.

Sometimes, deep scores get worn into brake rotors. This can happen if a worn-out brake pad is left on the car for too long. Break rotors can also warp; that is, lose their flatness. If this happens, the brakes may shudder or vibrate when you stop. Both of these problems can sometimes be fixed by refinishing (also called turning or machining) the rotors. Some material is removed from both sides of the rotors to restore the flat, smooth surface.

CHAPTER –IV

DESIGN METHODLOGY OF DISC BRAKING SYSTEM

4.1 Introduction to CATIA

CATIA (Computer Aided Three-dimensional Interactive Application) is a multi-platform CAD/CAM/CAE commercial software suite developed by the French company Dassault Systems. Written in the C++ programming language, CATIA is the cornerstone of the Dassault Systems product lifecycle management software suite. CATIA competes in the high-end CAD/CAM/CAE market with Cero Elements/Pro and NX (Unigraphics).

The 3D CAD system CATIA V5 was introduced in 1999 by Dassault Systems. Replacing CATIA V4, it represented a completely new design tool showing fundamental differences to its predecessor. The user interface, now featuring MS Windows layout, allows for the easy integration of common software packages such as MS Office, several graphic programs or SAPR3 products (depending on the IT environment).

The concept of CATIA V5 is to digitally include the complete process of product development, comprising the first draft, the Design, the layout and at last the production and the assembly. The workbench Mechanical Design is to be addressed in the Context of this CAE training course.

4.2 Modeling of Disc Brake System in CATIA V5

This **Disc Brake System** is designed using CATIA V5 software. This software used in automobile, aerospace, consumer goods, heavy engineering etc. it is very powerful software for designing complicated

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3d models, applications of CATIA Version 5 like part design, assembly design.

The same CATIA V5 R19 3d model and 2d drawing model is shown below for reference. Dimensions are taken from. The design of 3d model is done in CATIA V5 software, and then to do test we are using below mentioned software's.

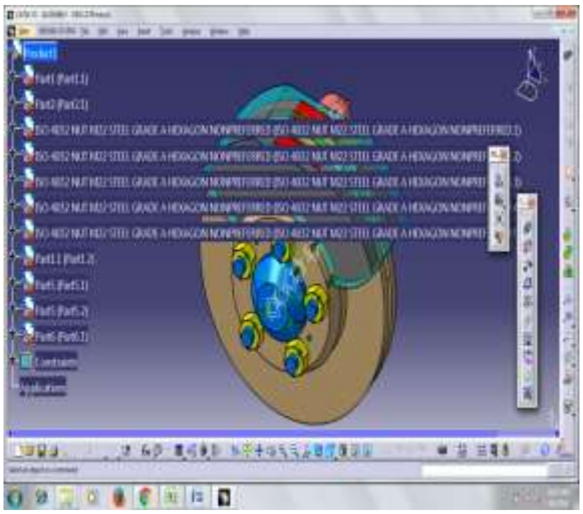

Fig: 4.1: Model design in CATIA-V5

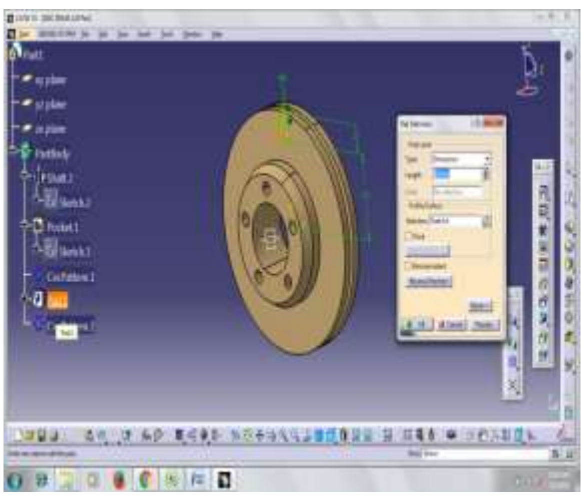

Fig: 4.2: Using Pad Command for thickness

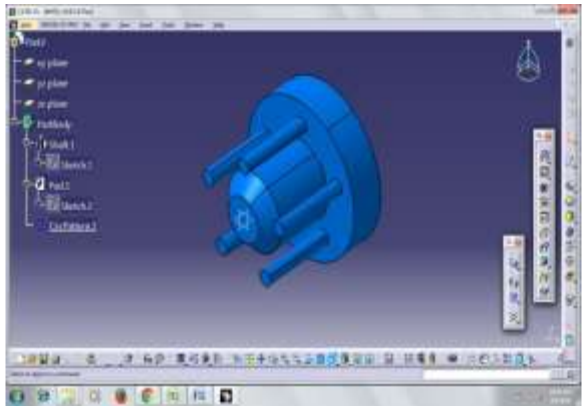

***Fig: 4.3:* Wheel Hub**

CHAPTER – V

ANALYSIS OF AUTOMOBILE DISC BRAKES

5.1 Preprocessor

In this stage the following steps were executed:

- **Import file in ANSYS window**

File Menu > Import> STEP > Click ok for the popped up dialog box > Click

Browse" and choose the file saved from CATIAV5R19 > Click ok to import the file

Mesh generation is the practice of generating a polygonal or polyhedral mesh that approximates a geometric domain. The term "grid generation" is often used interchangeably. Typical uses are for rendering to a computer screen as finite element analysis or computational fluid dynamics. The input model form can vary greatly but common sources are CAD, NURBS, B-rep and STL (file format). The field is highly interdisciplinary, with contributions found in mathematics, computer science, and engineering.

Three-dimensional meshes created for finite element analysis need to consist of tetrahedral, pyramids, prisms or hexahedra. Those used for the finite volume method can consist of arbitrary polyhedral. Those used for finite difference methods usually need to consist of piecewise structured arrays of hexahedra known as multi-block structured meshes.

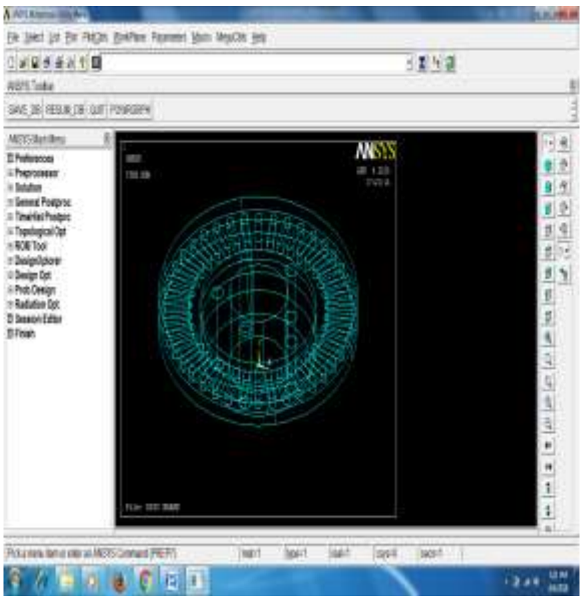

Fig.5.1: Imported file in Ansys from the system / directory

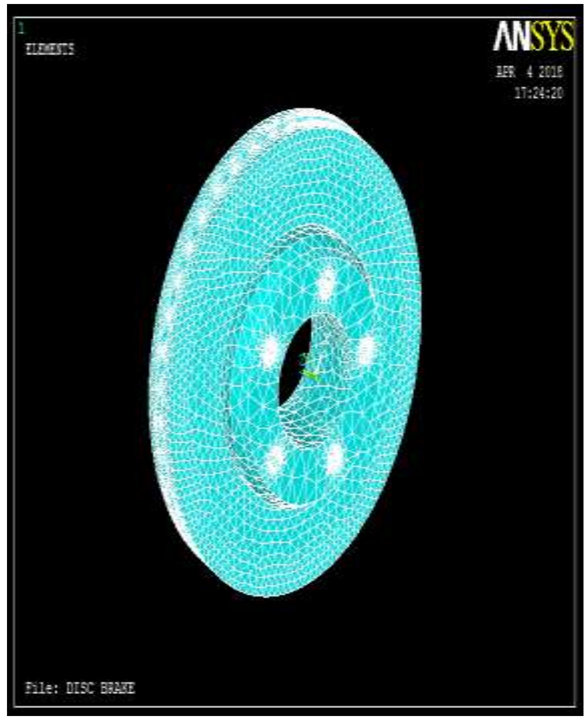

Fig.5.2 Disc Brake Meshing

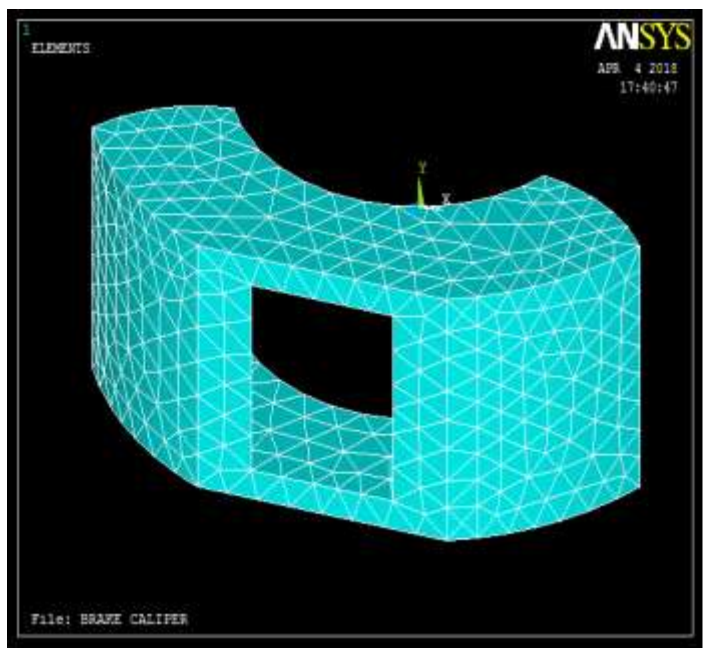

Fig.5. 3Brake Caliper Meshing

After completing the meshing of each assembly components next is to do analysis based on the OEM (Original Equipment of

Manufacturer) application. So all the models which are rotated along which axis that we need to mention.

CHAPTER-VI

DISCUSSION ON ANALYSYS RESULT

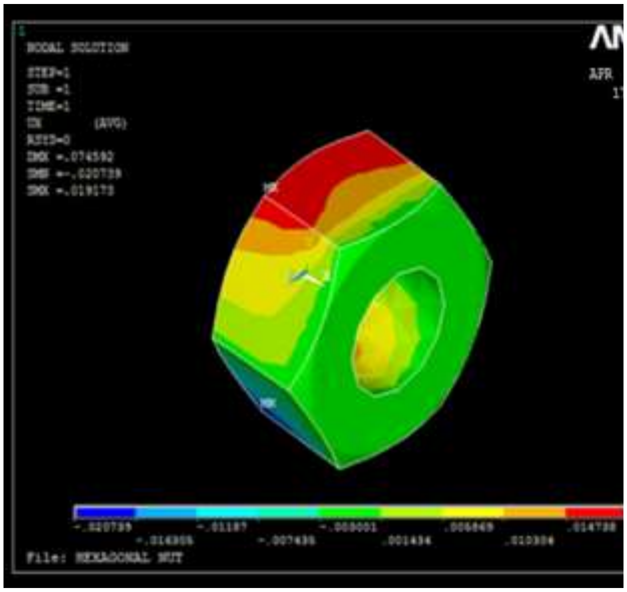

Fig:6.1: Displacement of Hexagonal Nut

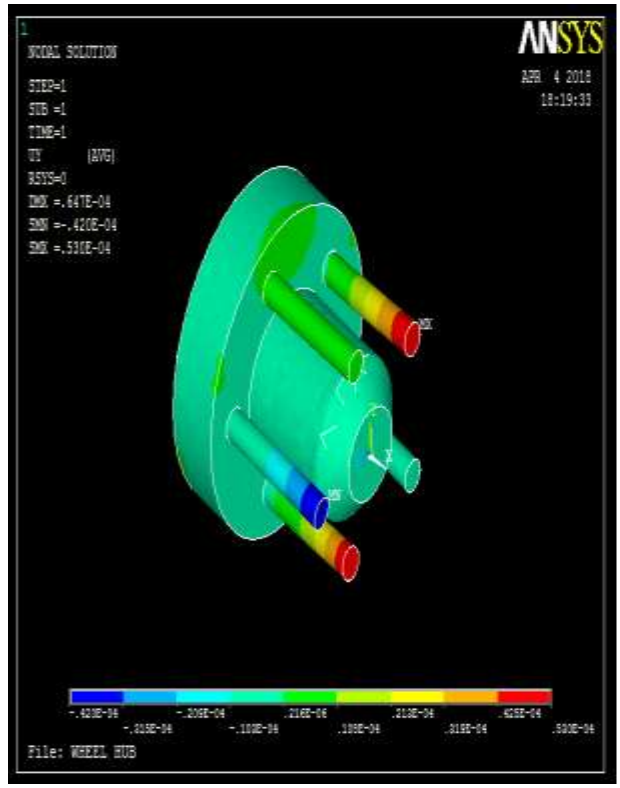

Fig: 6.2: Displacement of Hub

6.1 Results of Stress analysis

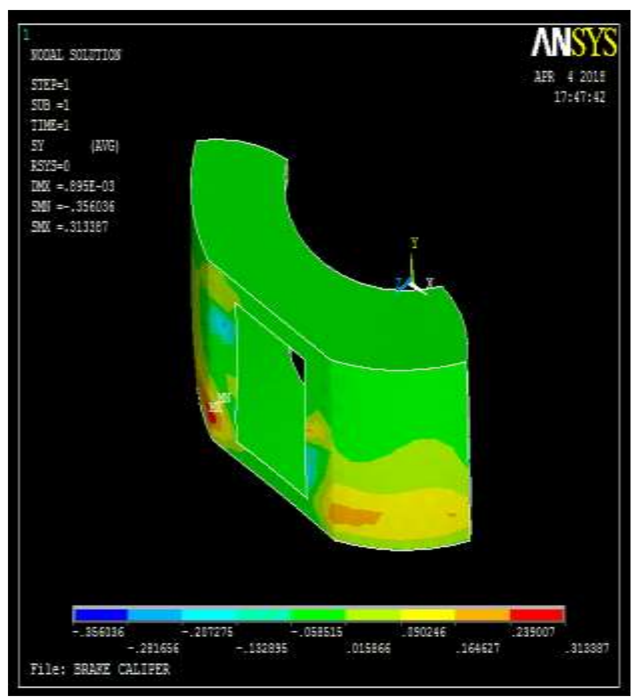

Fig: 6.2: Stress Analysis of Brake Caliper

CHAPTER – VII
CONCLUSION

A highly nonlinear model for the dynamic behavior is considered. A parametric study to investigate the influence of the control parameters on the dynamic response is conducted. The control parameters that influence the transient response are found to be dimensionless equation is developed to predict the settling time of the response. Based on the developed equation, the Optimum values of the control parameters are obtained.

As shown in above figures of the Brake pad the results are given as below, that the displacements of the components is meshed and solved using Ansys and displacement is 0.449E-04 mm which is very less. This is showing us that clearly each component in assembly is having minor displacement.

Stress is at the fixing location (Minimum Stress which is acceptable), stress value is 0.062 MPa. The value which is very less compared to yield value of given materials; this is below the yield point.As shown in above figures the components are designed and showing us that clearly each component in assembly solved successfully.

1.The optimal mathematical model which includes deformation of disc braking system and quality of disc brakes and disc pad calipers.
2.The design is carried out for standard brake model used in vehicle and the better result.

The final result positive manner .There is no problem while in Final assembly design; without failure. For proving that above analysis is carried out for applying displacements and force analysis.

CHAPTER – VIII
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