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DESIGN AND ANALYSIS ON AUTOMATIC DISC BRAKING SYSTEM

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Abstract: *A brake is a mechanical device which inhibits motion. A disc brake is a brake that uses friction caused by a set of pads that press against a rotating disc-shaped part called a disc. The brake 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 pad with the friction material, the counter body and caliper, can be modeled. When the brake is applied repeatedly the brake pad undergoes critical designs to determination that is carried out. In this thesis, focus is on the design of the disc brake and its components. As perform solid-mechanical calculations, and a design, and experimentally investigate the structural analysis integrity of the components. For this project, there are basic requirements. The requirement is to design of a model. This system is done by modeling software's like CatiaV5.Then these models are analyzed in the Ansys software to find out the loads falling on it as part the impact on the design. In this project work has been taken up on the following aspects to cover the research gaps to present the results based on the systematic studies.*

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 vehicle 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.

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FIG: DISC BRAKING SYSTEM

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.

Compared to drum brakes, disc brakes offer better stopping performance because the disc is more readily cooled. As a consequence discs are less prone to the brake fade caused when brake components overheat. Disc brakes also recover more quickly from immersion (wet brakes are less effective than dry ones).

Most 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.

The disc is usually made of cast iron, but may in some cases be made of composites such as reinforced carbon–carbon or ceramic matrix composites. This is connected to the wheel and/or the axle. To retard the wheel, friction material in the form of brake pads, mounted on the brake caliper, is forced mechanically, hydraulically, pneumatically, or electro magnetically against both sides of the disc. Friction causes the disc and attached wheel to slow or stop.

II - LITERATURE SURVEY

Tribological performance characterization of brake friction materials: What test? What coefficient of friction?; Mohamed Kchaou, Amira Sellami, This article describes and explains the tribological tests and methods for the evaluation of the performance of the brake friction materials. It starts by discussing the particularities of these materialsand the variation of characterization tests, which can experimentally simulate many aspects of brake situation but with a large field of tribo-test, from standard to specific protocol. Examples of

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preparation, procedures, instrumentation, and analysis results for the tribological aspect testing ranging from the scale of vehicle braking performance (by methods including inertia dynamometers, Krauss testing, friction assessment screening test, and Chase testing) to simplified test using reduced-scale prototypes for small-sample friction, are explained. A particular attention is attributed to the discussion of the viability of the friction coefficient report in relation to the material properties and brake compound performance. At the end of this article, the guarantee of the performance output or ranking evaluated by such experimental methods is discussed.

Thermomechanical Modelling of Disc Brake Contact Phenomena; Belhocine Ali; In this publication, we presented the analysis of the thermomechanical behavior of the dry contact between the brake disc and pads; the modeling is based on the ANSYS 11.0. We have shown that the ventilation system plays an important role in cooling disks. The analysis results showed that temperature field and stress field in the process of braking phase were fully coupled. The temperature, Von Mises stress and the total deformations of the disc and contact pressures of the pads increase as the thermal stresses are additional to mechanical stress which causes the crack propagation and fracture of the bowl and wear of the disc and pads. It would be interesting to solve the problem in thermomechanical disc brakes with an experimental study to validate the numerical results, for example on test benches, in order to show a good agreement between the model and reality

Review on Ceramic Disc Brake System; S. Manavalan, Aswin Gopi, J. Arivarasu, A. Abishek Ahi, S. Chandru; Braking is a method that converts mechanical energy of the vehicle into mechanical energy that should be dissipated in the type of heat. While not break within the vehicle can place a rider within the unsafe position. Brakes convert friction to heat, however, if the brakes get too hot, they're going to stop to figure as a result of they can't dissipate enough heat. Therefore, researches area unit occurring during this field for decreasing the temperature result so by this we are able to operate simply. Several new materials area unit introduced for the disc brake rotor to resist warm temperature made throughout braking action. With the exception of the warm temperature property, the disc rotor materials should even have high thermal physical phenomenon property, as this property decides the number of warmth dissipation to the air stream from the disk rotor. Within the gift work, a gray forged iron material and metal-ceramic have been chosen for the disc brake rotor. To conclude the temperature history for the gray forged iron material, and metal-ceramic, anumerical simulation technique known as finite technique is employed. Transient analysis is applied in ANSYS to predict temperature distribution as a operate of your time within the disc brake rotor. The results from the transient analysis area unit compared. It’s necessary to try and do the structural analysis when playacting thermal analysis in ANSYS to review the steadiness and rigidity behavior of the rotor material. The results obtained by finite component simulation and smart material are urged. The study of ceramic disc brake system ANSYS software package is employed to the transient thermal analysis drawback with resistance heat generation. to get the simulation of thermal behavior showing in numerous disc brake rotor material, the fundamental governing equation for the warmth conductivity is solved with the initial boundary conditions and therefore the thermal load like heat flux at the brake rotor and pad interface for the 3 materials. Here once the carbon material is employed in rather than traditional ceramic disk brake. By adding it reduces the warmth production as

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it's an honest conductor of warmth. Thus, by increasing the lifetime of brake and conjointly increasing mileage as weight is relatively less compared with others.

Structural Analysis Of Brake Disc Plate Using Threedifferent Materials; Pappuri Hazarathaiah, M.Sreenivasulu; Disc(Rotor) brakes are exposed to large thermal stresses during routine braking and extraordinary thermal stresses during hard braking. The aim of the project is to design, model a disc. Modeling is done using NX/UG. Structural analysis is to be done on the disc brakes using three materials Stainless Steel and Cast iron carbon carbon composite. Structural analysis is done on the disc brake to validate the strength of the disc brake. Comparison can be done for deformation, stresses etc. form the three materials to check which material is best. NX/UG is a 3d modeling software widely used in the design process. HYPERMESH is general-purpose finite element analysis (FEA) software package. Finite Element Analysis is a numerical method of deconstructing a complex system into very small pieces (of user-designated size) called elements. In this paper, we have designed a brake disc plate. have modeled the brake disc plate by using 3D parametric software UNIGRAPHICS. To validate the strength of our design, we have done structural analysis on the brake disc plate. We have done analysis on brake disc plate for different materials like Cast iron, Stainless steel and Carbon carbon composite. By comparing the stress results for three materials, the Vonmises stress value is less for Carbon carbon composite than Cast iron and Stainless steel. By comparing the deformation results for three materials, the total deformation value is less for Carbon carbon composite than Cast iron and Stainless steel. By observing the analysis results, the analyzed stress.

III - DESCRIPTION OF PROJECT

Optimization through genetic algorithm yields better results in the machine element design under certain circumstances. The same design through traditional methods has some drawbacks such as there is a chance for the solutions get trapped into local minima. The algorithm developed for one type of problem, may not be suitable to solve another type of problem. In this context, the real coded genetic algorithm proved to be a versatile design optimization algorithm for design of machine elements. The design optimization procedure adopted by these authors is as such incorporated in this work to determine the exact dimensions of a brake disc.

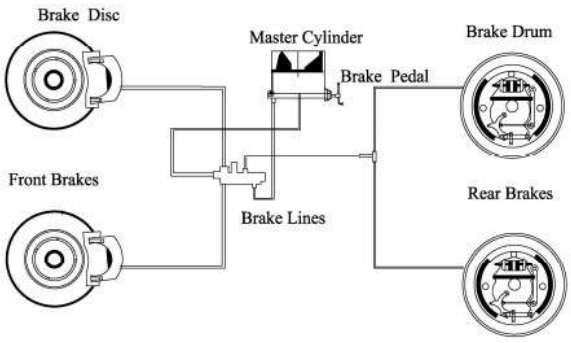

Fig: Layout of Disc Braking System

An approach to the thermal modeling of disc brakes. This literature deals with four different modeling approaches for the thermal analyses of disc brakes. The models ranging from a simple lumped-parameter model to a complex three dimensional model. The lumped parameter (zero dimensional model) rotor model predicts transient bulk rotor temperature, while a one dimensional model provides peak surface as well as bulk temperature. The steady state two-dimensional model of the entire brake system predicts plateau temperatures during a multi-stop driving schedule. Finally, a complex three dimensional transient model can be used to obtain detailed local rotor temperature distribution for any stopping sequence. The fundamentals pertaining to conductive and convective heat transfers and the thermal network modeling concept was reviewed from this literature and they were incorporated.

IV - WORKING MECHANISM AND 2D DRAWINGS

Most modern cars have disc brakes on the front wheels, and some have disc brakes on all four wheels. This is the part of the brake system that does the actual work of stopping the car. The most common type of disc brake on modern cars is the single-piston floating caliper. In this article, we will learn all about this type of disc brake design.

Normal Braking

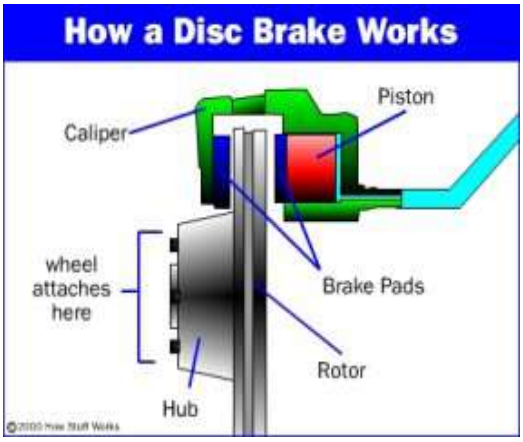

Fig: Normal Braking

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.

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.

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Vented disc brakes have a set of vanes, between the two sides of the disc, that pumps air through the disc to provide cooling.

2D Drawings of Disc Braking System

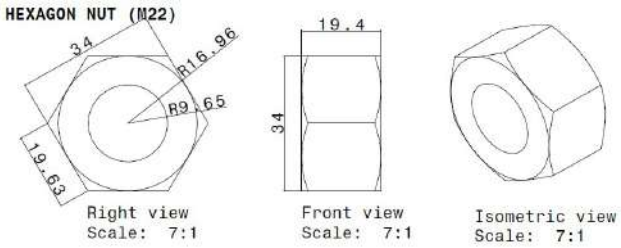

Fig: Hex Nut (M22)

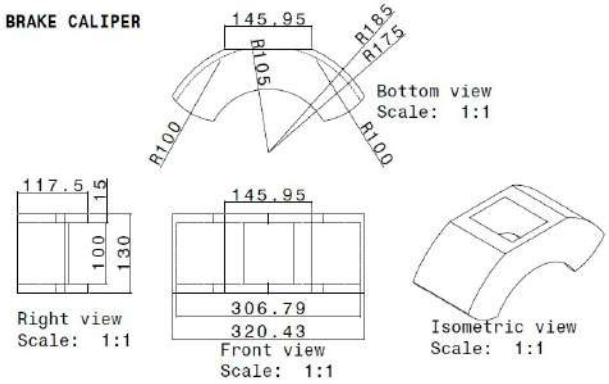

Fig: Brake Calipers

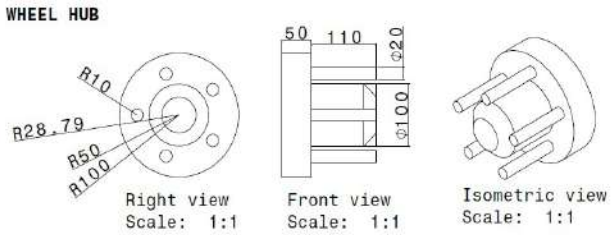

Fig: Wheel Hub

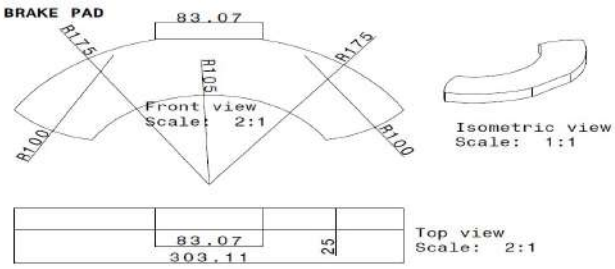

Fig: Brake Pad

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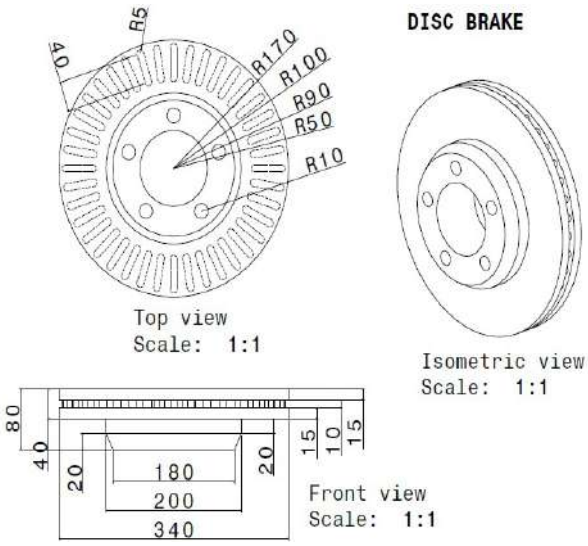

Fig: Disc Brake

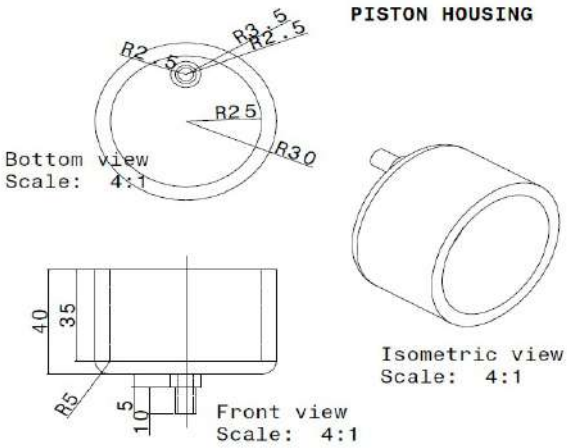

Fig: Piston Housing

V - DESIGN METHODLOGY OF DISC BRAKING SYSTEM

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

The same CATIA V5 R20 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.

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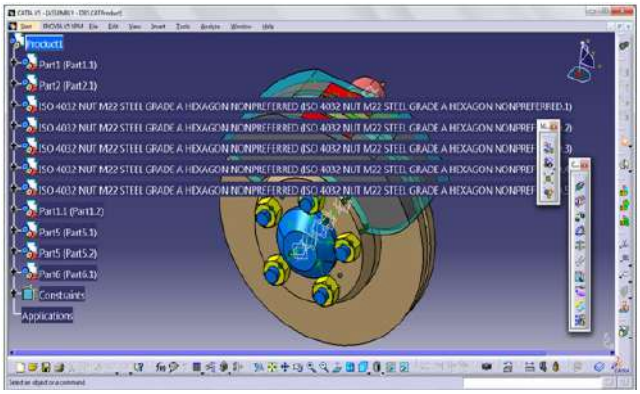

Fig: Model design in CATIA-V5

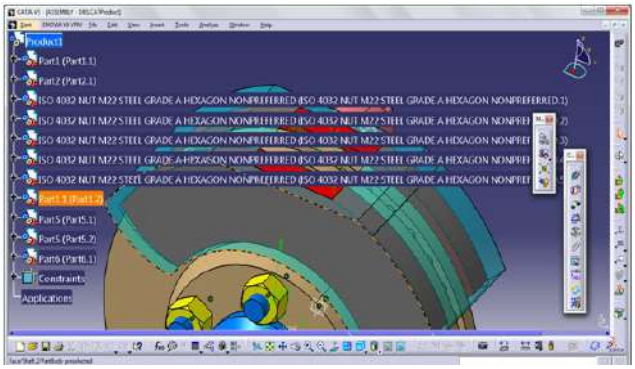

Fig: Model arrangement in CATIA-V5

VI - ANALYSIS OF AUTOMOBILE DISC BRAKE

Procedure for FE Analysis Using ANSYS:

The analysis is done using ANSYS. For compete assembly is not required, motor and attached system is to carried out by applying moments at the rotation location along which axis we need to mention. Fixing location is bottom legs of assembly of the craft.

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 CATIAV5R20 > Click ok to import the file

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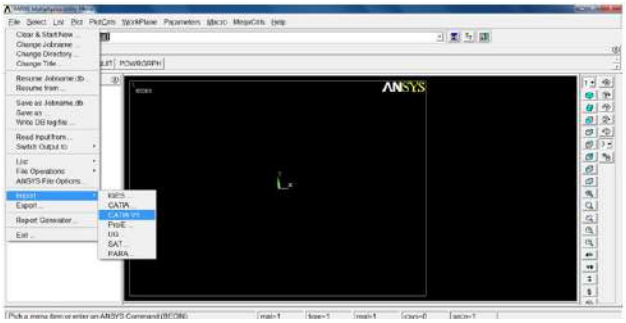

Fig: Import panel in Ansys.

VII - DISCUSSION ON ANALYSYS RESULT

Results of Displacement analysis:

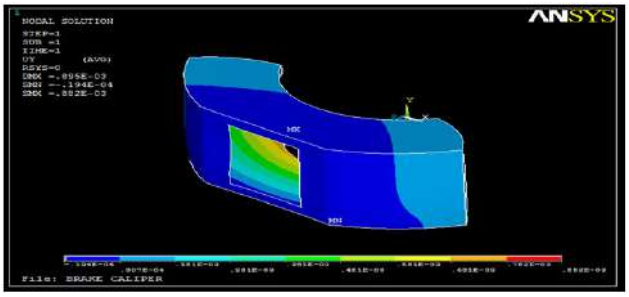

Fig: Displacement of Brake Caliper

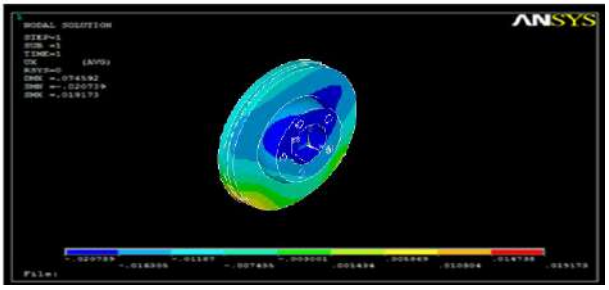

Fig: Displacement of Disc Brake

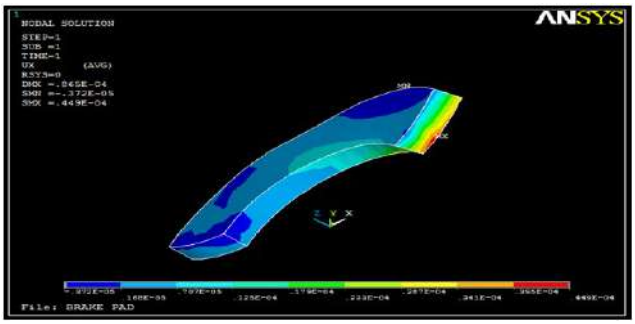

Fig: Displacement of Brake Pad

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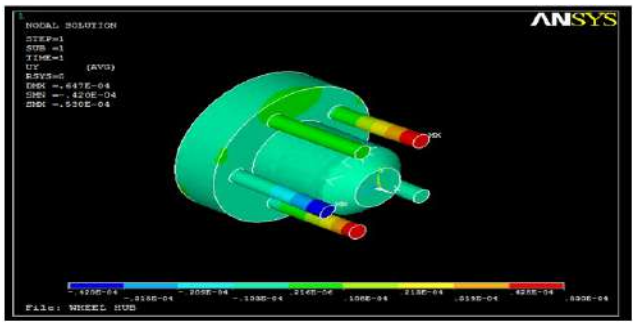

Fig: Displacement of Hub

Results of Stress analysis:

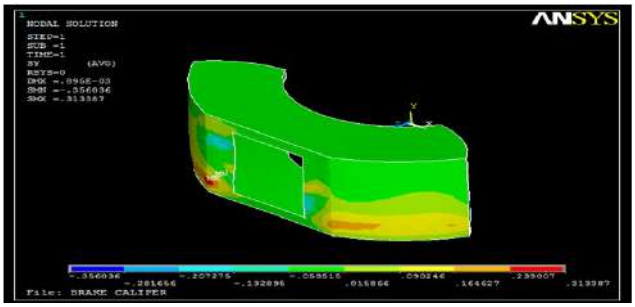

Fig: Stress Analysis of Brake Caliper

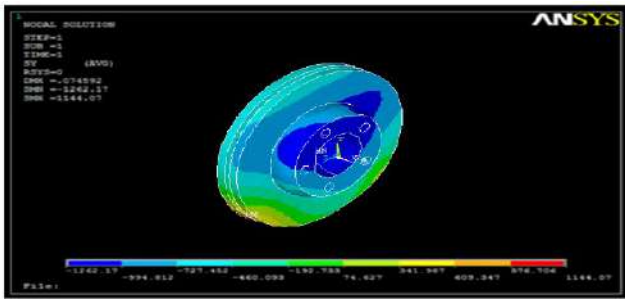

Fig: Stress Analysis of Disc Brake

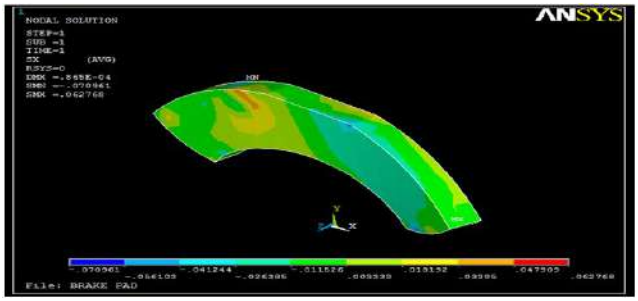

Fig: Stress Analysis of Brake Pad

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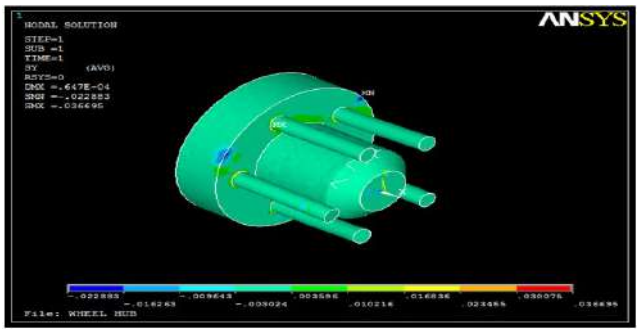

Fig: Stress Analysis of Hub

Results of Strain analysis:

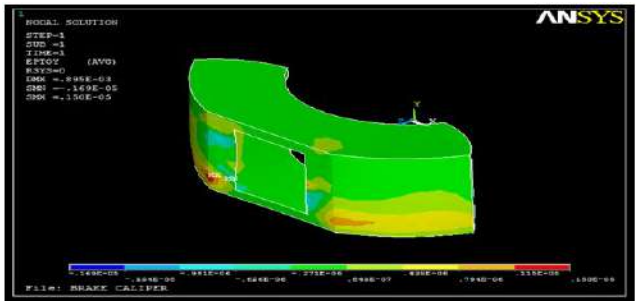

Fig: Strain Analysis of Brake Caliper

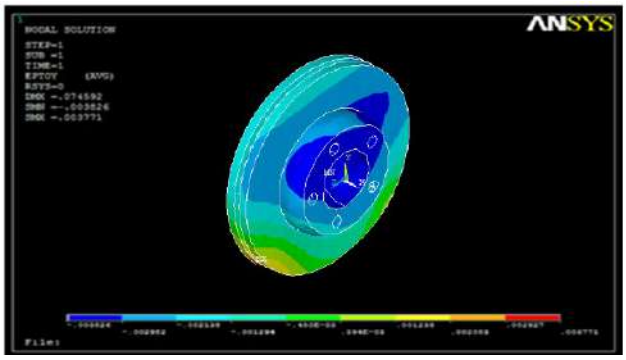

Fig: Strain Analysis of Disc Brake

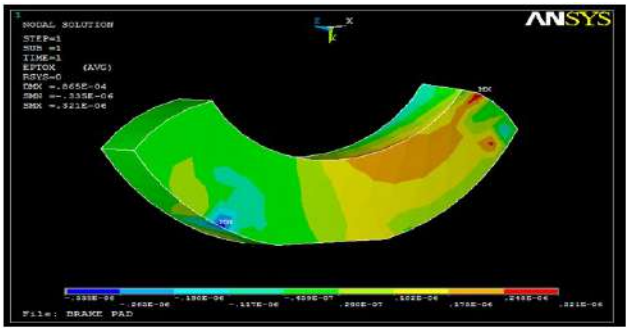

Fig: Strain Analysis of Brake Pad

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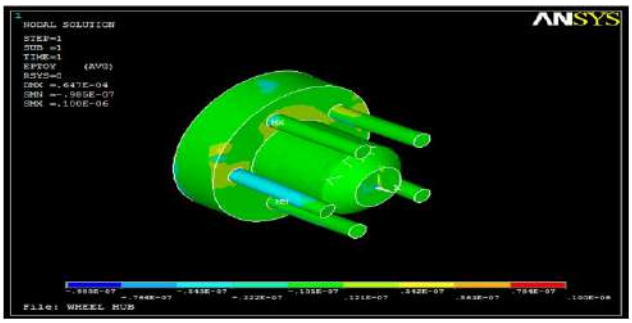

Fig: Strain Analysis of Hub

VIII - 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 the displacements of the components is meshed and solved using Ansys and displacement is 0.019173 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 1144.07 MPa. The value which is very less compared to yield value of given materials; this is below the yield point. The Strain value is 0.003771.

As shown in above figures the components are designed and showing us that clearly each component in assembly solved successfully.

- The optimal mathematical model which includes deformation of disc braking system and quality of disc brakes and disc pad calipers.
- 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.

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