ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 4, Issue 4, April 2017

FABRICATION DESIGN AND ANALYSIS OF DISK BRAKE

[1]N.RAHUL, [2]K.SRINIVASA RAO

[1]PG Scholar, Department of MECH, Mallareddy Engineering College Hyderabad, Telangana, INDIA

Email:rahul.n14311@gmail.com

[2] Associate Professor Department of MECH, Mallareddy Engineering College Hyderabad,

Telangana, INDIA

Email:srinivas7727@gmail.com

Abstract:

A disc brake is a wheel brake that moderates pivot of the wheel by the contact caused by pushing brake cushions against a brake plate with an arrangement of calipers. Plate brake offer higher execution, light weight, less complex plan, preferable protection from water interface over drum brakes

The brake plate is typically made of solid metal, yet may at times be made of composites, for example, strengthened carbon– carbon or earthenware framework composites. This is associated with the haggle/the pivot. To stop the wheel, grating material as brake cushions, mounted on a gadget called a brake caliper, is constrained mechanically, using pressurized water, pneumatically, or electromagnetically against the two sides of the plate. Grinding makes the plate and appended wheel moderate or stop. Brakes change over movement to warm, and if the brakes get excessively hot, they turn out to be less viable, a marvel known as brake blur.

In this project we will machined a disc brake by using the material Al+stainless steel hot rolled material with ventilated holes , and then we modeled the same dimension disc brake in CAD by using solidworks 2016 software. Static structural ,thermal and modal (dynamic) analysis is performed in ANSYS workbench software by applying same materials properties of Hot rolled stainless steel+AL and generally used grey cast iron on given loadconditions of brake pressure load and heat generated by brake friction.

Hence we can find out stress strain and deformation on disc brake which we have manufacture , by using static structural analysis, thermal heat distribution by thermal analysis and dynamic behavior of disc brake by using modal analysis.

Introduction:

A brake is a device which is accustomed to convey to rest or back off a moving body. Safe operation of vehicle requests tried and true brakes is required to assimilate the dynamic energy of the moving parts or the potential energy of the protest being brought down by have when the rate of drop is controlled. The energy consumed by brakes is scattered as warmth. This warmth is scattered in the encompassing air to stop the vehicle, so the slowing mechanism ought to have following prerequisites:

- The brakes must be sufficiently solid to stop the vehicle with in a base separation in a crisis.
- The driver must have legitimate control over the vehicle amid braking and vehicle must not slide.

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 4, Issue 4, April 2017

- The brakes must have well hostile to blur attributes i.e. their adequacy ought not diminish with is steady drawn out application.
- The brakes ought to have well hostile to wear properties.

The imperative necessities of the brake drum are following:

- It ought to give a surface having great against wear qualities.
- It ought to permit the ideal rate of warmth exchange.
- Heat is created amid each brake application and it must be dispersed to the environment promptly, in light of the fact that the following brake application would again deliver more warmth. Any abundance warming of brakes would make the drum extend bringing about loss of successful pedal travel and blurring of brake lining.
- It ought to have adequate quality however least weight.
- It ought to have the capacity to be suited inside the wheel space accessible.

Fig: disc brake

Classification:

On the Basis of Method of Actuation

(a) Foot brake (also called service brake) operated by foot pedal

(b) Hand brake – it is also called parking brake operated by hand.

On the Basis of Mode of Operation

(a) Mechanical breaks

(b) Hydraulic brakes

(c) Air brakes

(d) Vacuum brakes

(e) Electric brakes.

On the Basis of Action on Front or Rear Wheels

(a) Front-wheel breaks

(b) Rear-wheel brakes.

On the Basis of Method of Application of Braking Contact

(a) Internally – expanding brakes

(b) Externally – contracting brakes.

Types of brakes:

1. Drum brakes
2. Disc brakes
3. Parking brakes
4. Anti lock braking system
5. Vacuum brakes
6. Hydraulic brakes

Disk brakes:

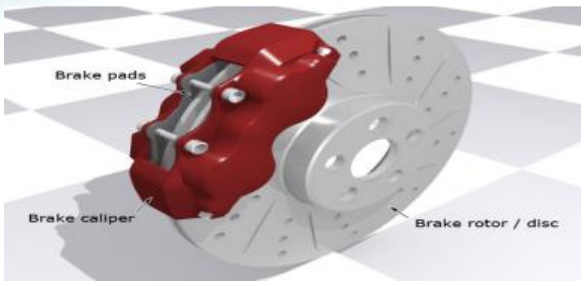


Fig: Disc brake

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 4, Issue 4, April 2017

The disc brake is a wheel brake which slows rotation of the wheel by the friction caused by pushing brake pads against a brake disc with a set of calipers. The brake disc (or rotor in American English) is generally made of solid metal, however may now and again be made of composites, for example, fortified carbon–carbon or fired grid composites. This is associated with the haggle/the hub. To stop the wheel, rubbing material as brake cushions, mounted on a gadget called a brake caliper, is constrained mechanically, powerfully, pneumatically or electromagnetically against the two sides of the plate. Grinding makes the circle and joined wheel moderate or stop. Brakes change over movement to warm, and if the brakes get excessively hot, they turn out to be less compelling, a marvel known as brake blur. [5] discussed about a project, in this project an automatic meter reading system is designed using GSM Technology. The embedded micro controller is interfaced with the GSM Module. This setup is fitted in home. The energy meter is attached to the micro controller. This controller reads the data from the meter output and transfers that data to GSM Module through the serial port. The embedded micro controller has the knowledge of sending message to the system through the GSM module. Another system is placed in EB office, which is the authority office. When they send “unit request” to the microcontroller which is placed in home. Then the unit value is sent to the EB office PC through GSM module. According to the readings, the authority officer will send the information about the bill to the customer. If the customer doesn’t pay bill on-time, the power supply to the corresponding home power unit is cut, by sending the command through to the microcontroller. Once the payment of bill is done the power supply is given to the customer. Power management concept is introduced, in which during the restriction mode only limited amount of power supply can be used by the customer.

Components of disk brakes:

The brake disc is the part of a circle brake against which the brake cushions are connected. The material is normally dim iron, a type of cast press. The design of the circle shifts to some degree. Some are just strong, however others are dug out with balances or vanes consolidating the circle's two contact surfaces (normally included as a major aspect of a throwing procedure). The weight and energy of the vehicle decides the requirement for ventilated discs. The "ventilated" circle configuration disperses the created warm and is generally utilized on the all the more intensely stacked front discs.

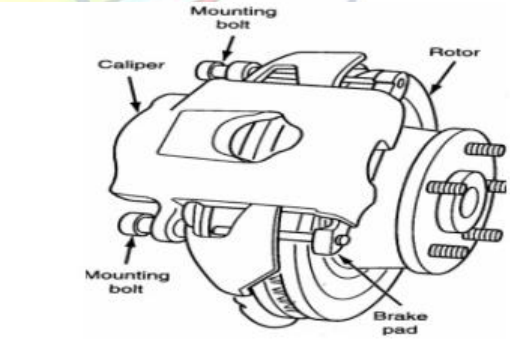


Fig: disc brake components

Advantage of Disc Brakes

(a) Fundamental preferred standpoint of disc brakes is their protection from wear as the plates remain cool even after rehashed brake applications.

(b) Brake cushions are effectively replaceable.

(c) The state of brake cushions can be checked without much destroying of brake framework.

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 4, Issue 4, April 2017

Disadvantage of Disc Brakes

(a) More power is required be connected as the brakes are not self rising.

(b) Pad wear is more.

(c) Hand brakes are not successful if plate brakes are utilized as a part of back wheels also.(Hand brakes are better with mechanical brakes.

FABRICATION OF DISC BRAKE:

In modern days, the use of metal is vast and there are various methods of manufacturing a product from only use of pure molten metal or from any other state of metal as well. When considering the different methods of manufacturing, most popular methods used in large industries are as follows:

- Metal Casting
- Metal Cutting
- Metal Forming and shaping
- Fabrication and welding

The Materials used for the manufacturing process

Hot rolled stainless steel+AL forged part

Equipment/tools used for manufacturing

Milling machine

Drilling machine

Grinding machine

OPERATION OR PROCESS:

Milling machine:

Faces has been cleaned, and cut the slots

Drilling machine:

Different sizes of holes are made.

Grinding operation:

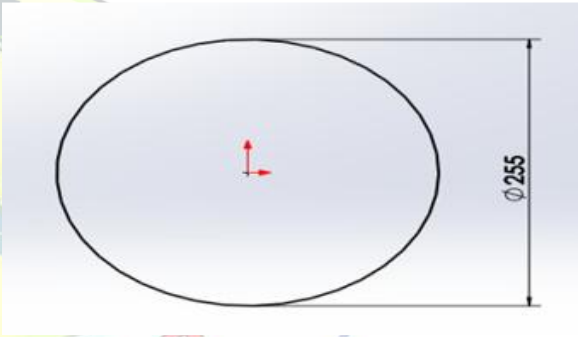
For removing burs, sharp edges and giving final finishing on surface.

SOLID WORKS

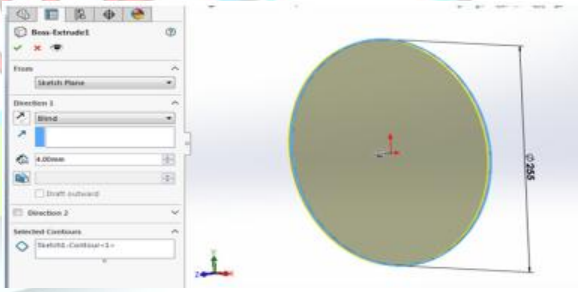
Solid Works is mechanical design automation software that takes advantage of the familiar Microsoft Windows graphical user interface. It is an easy-to-learn tool which makes it possible for mechanical designers to quickly sketch ideas, experiment with features and dimensions, and produce models and detailed drawings.

Design of disk brake:

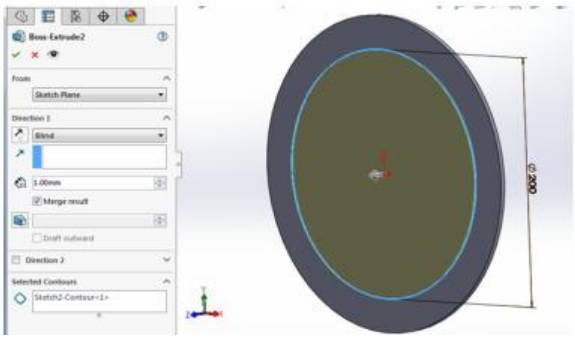
Draw the sketch as follow dimensions.



Extrude the 2d sketch and provide the thickness for disc brake plate

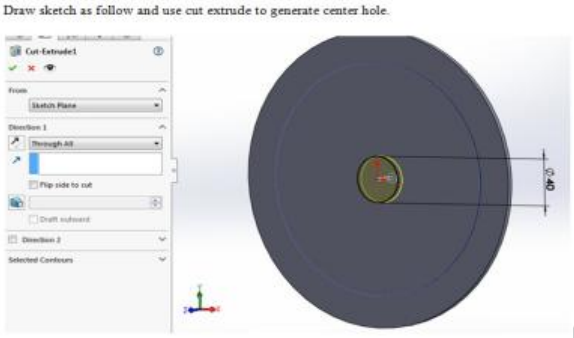


Draw sketch on plate face and extrude as follow.

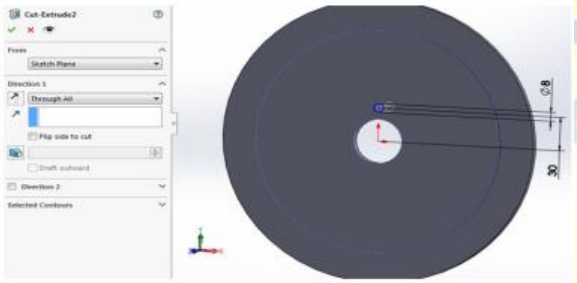


ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 4, Issue 4, April 2017

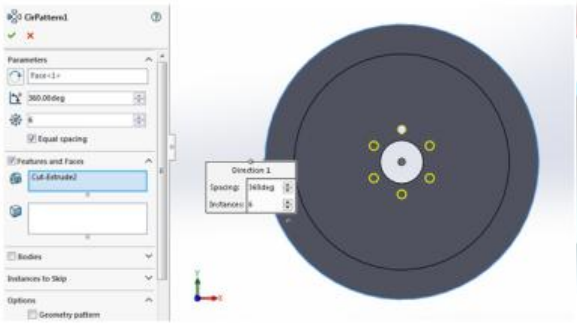
Draw sketch as follow and use cut extrude to generate center hole.



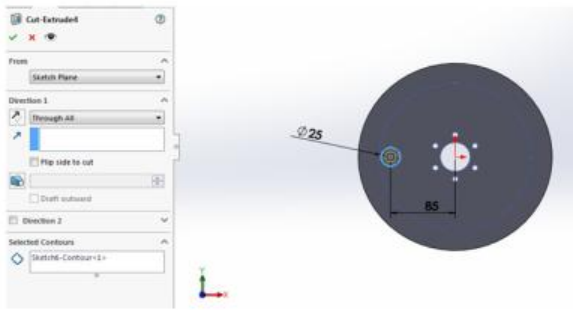
Draw sketch as follow and use cut extrude to generate hole.



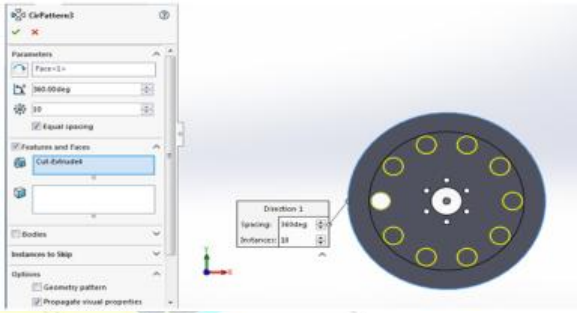
Use circular pattern command and pattern the hole accordingly.



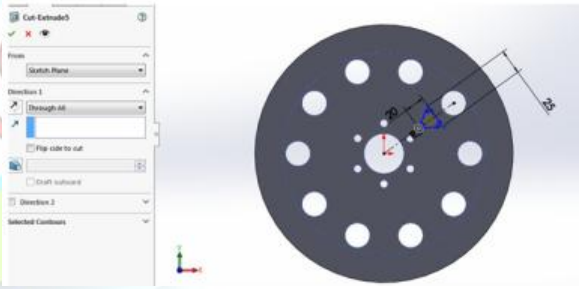
Draw sketch as follow and use cut extrude to generate hole.



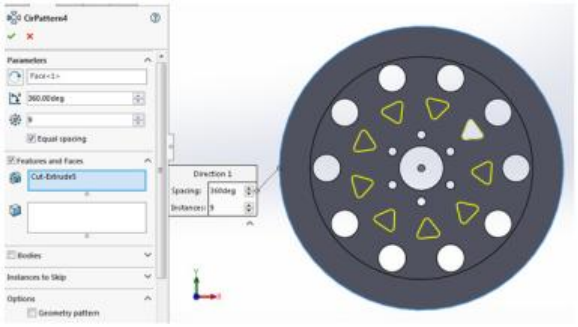
Use circular pattern command and pattern the hole accordingly.



Draw sketch as follow and use cut extrude to generate slot cut.

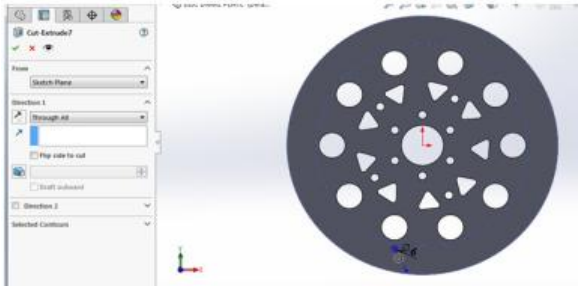


Use circular pattern command and pattern the slot cut accordingly.

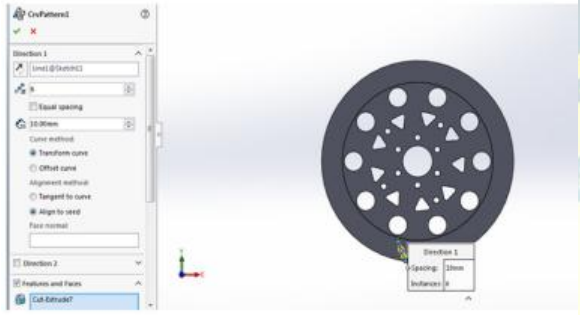


ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 4, Issue 4, April 2017

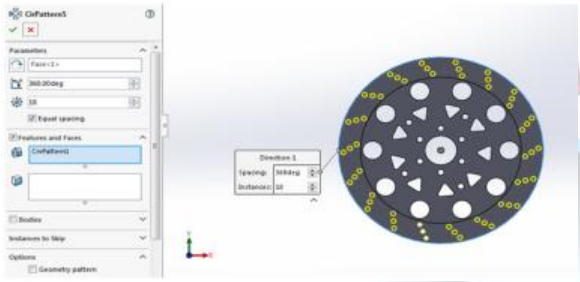
Draw sketch as follow and use cut extrude to generate hole.



Use curve driven pattern command and pattern the hole according to straight curve.



Use circular pattern command and pattern the curve driven pattern accordingly.



3d model of disc brake plate

Finite Element Analysis

Introduction

Finite Element Analysis (FEA) is a computer-based numerical technique for calculating the strength and behaviour of engineering structures. It can be used to calculate deflection, stress, vibration, buckling behaviour and many other phenomena. It additionally can be utilized to investigate either little or largescale diversion under stacking or connected uprooting. It utilizes a numerical system called the Finite element method (FEM).

INTRODUCTION TO SIMULATION

Simulation is a design analysis system. Simulation provides simulation solutions for linear and nonlinear static, frequency, buckling, thermal, fatigue, pressure vessel, drop test, linear and nonlinear dynamic, and optimization analyses.

Introductions to ANSYS

ANSYS delivers innovative, dramatic simulation technology advances in every major Physics discipline, along with improvements in computing speed and enhancements to enabling technologies such as geometry handling, meshing and post-processing.

Static Analysis

Static analysis deals with the conditions of equilibrium of the bodies acted upon by forces. A static analysis can be either linear or non-linear. All types of non-linearity's are allowed such as large deformations, plasticity, creep, stress stiffening, contact elements etc.

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 4, Issue 4, April 2017

Thermal Analysis:

Changes in temperature can induce substantial deformations, strains, and stresses. Thermal analysis refers to analysis that includes the effect of temperature.

Modal analysis

When an elastic system free from external forces is disturbed from its equilibrium position it vibrates under the influence of inherent forces and is said to be in the state of free vibration. It will vibrate at its natural frequency and its amplitude will gradually become smaller with time due to energy being dissipated by motion. The main parameters of interest in free vibration are natural frequency and the amplitude.

ANALYSIS ON DISC BRAKE

Disc brake is imported in Ansys16.0 in geometry

Material properties:

Al+stainless steel hotrolled

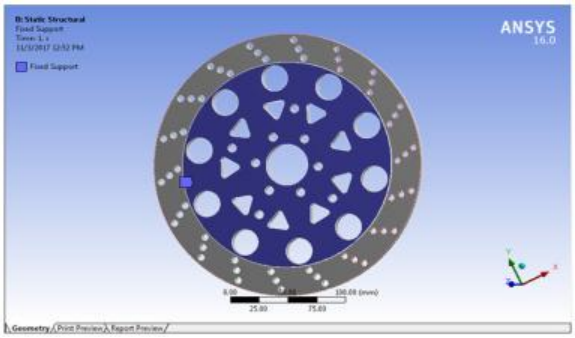
Density (kg/mm3)	Young modulus (mpa)	Poisons ratio	Bulk modulus (mpa)	Shear modulus (mpa)	Thermal conductivity (W/m-k)	Tensile ultimate strength (mpa)
7850	2.129E+05	0.26	1.51E+05	8.4154E+04	16.2	505

Grey Cast Iron

Density (kg/mm3)	Young modulus (mpa)	Poisons ratio	Bulk modulus (mpa)	Shear modulus (mpa)	Thermal conductivity (W/m-k)	Tensile ultimate strength (mpa)
7200	1.1E+05	0.28	8.3333E+04	4.2969E+04	52	240

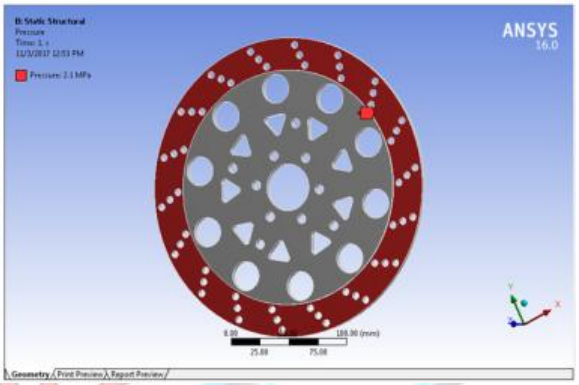
STATIC STRUCTURAL ANALYSIS

Fixed support



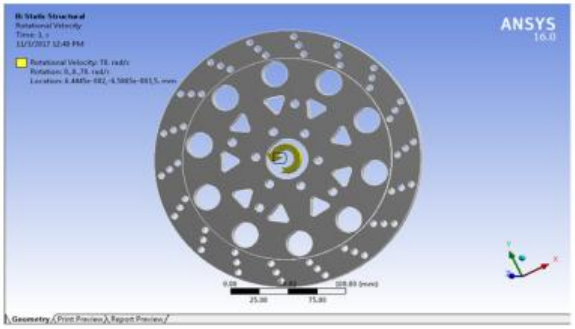
Pressure applied

Pressure applied is 2.1 mpa.



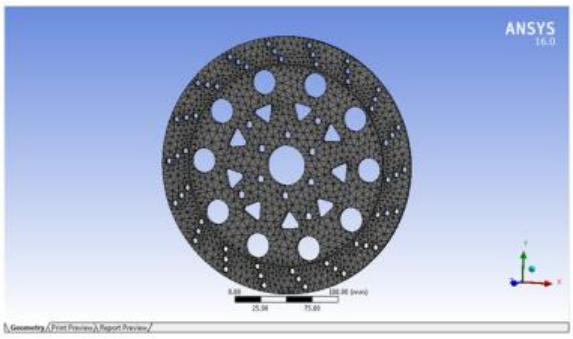
Rotational velocity

Rotation velocity applied is 70 rad/sec.

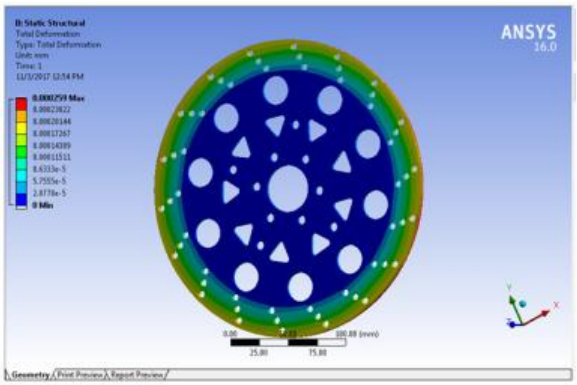


ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 4, Issue 4, April 2017

Mesh



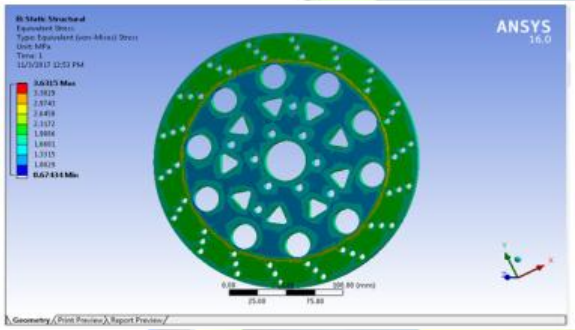
Deformation



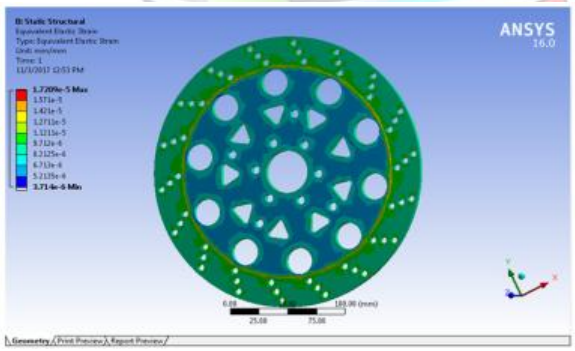
RESULTS

Material: Hot Rolled Stainless Steel + Al

Stress

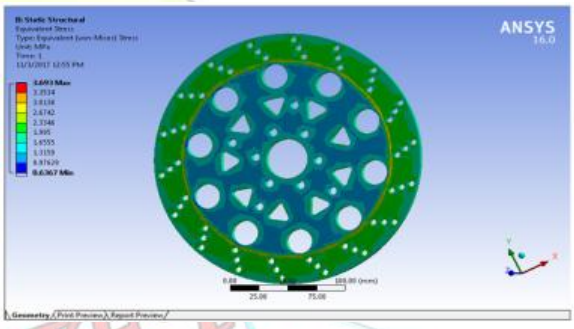


Strain

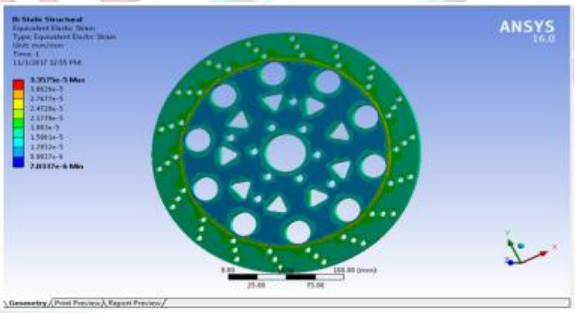


Material: Grey Cast Iron

Stress

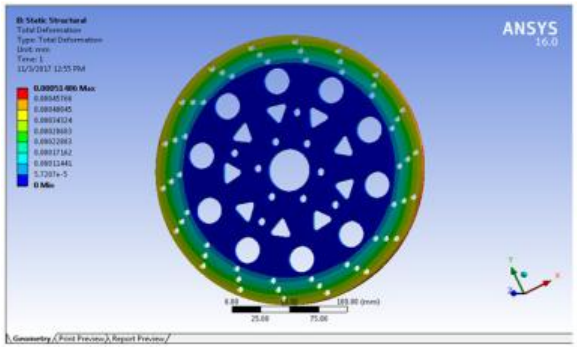


Strain



ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 4, Issue 4, April 2017

Deformation

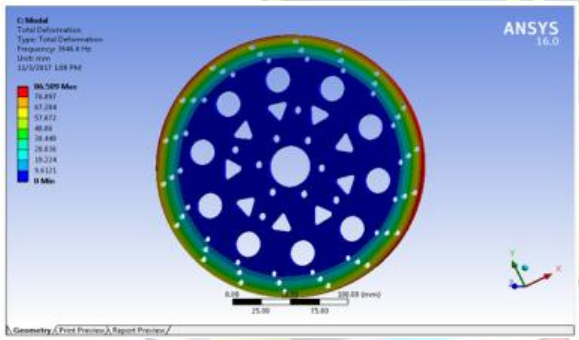


MODAL ANALYSIS (DYNAMIC)

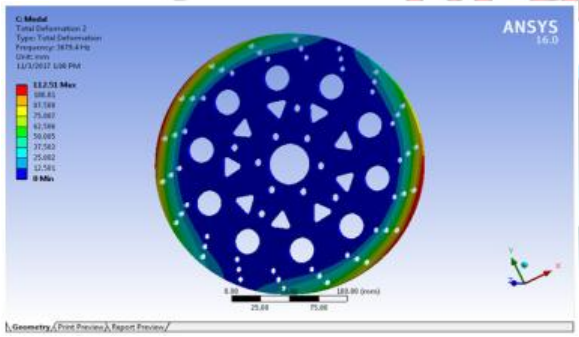
RESULTS

Material: Hot rolled Stainless Steel + AL

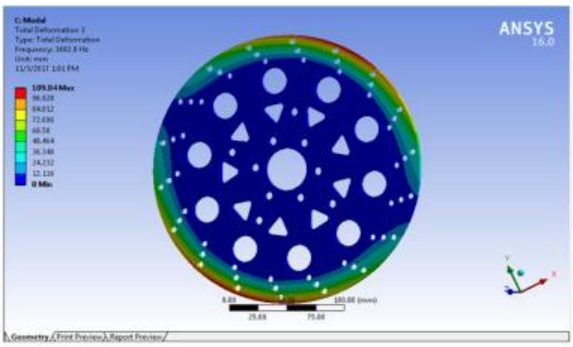
Mode1



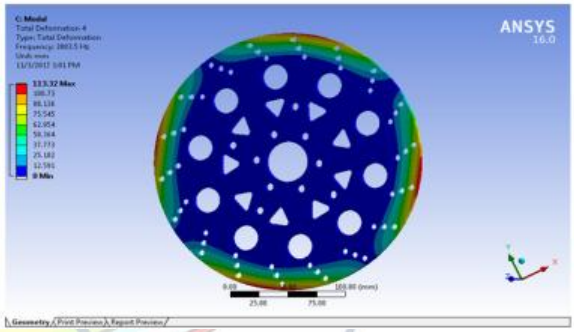
Mode2



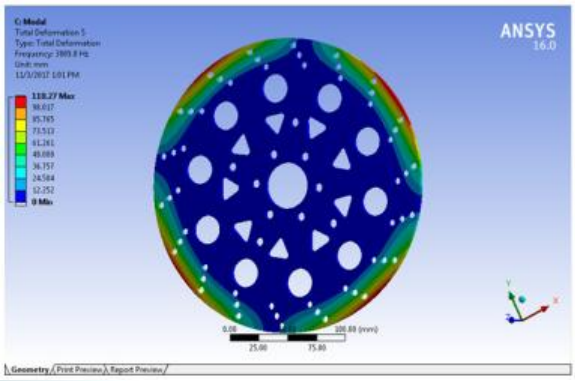
Mode3



Mode4

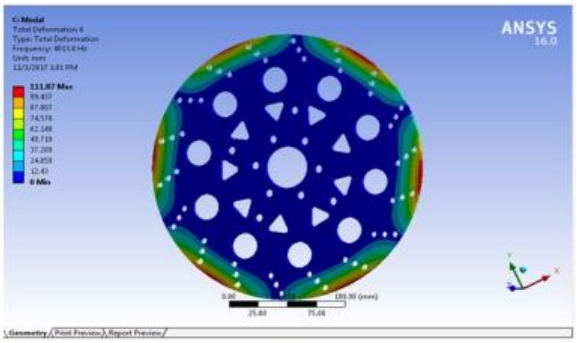


Mode5

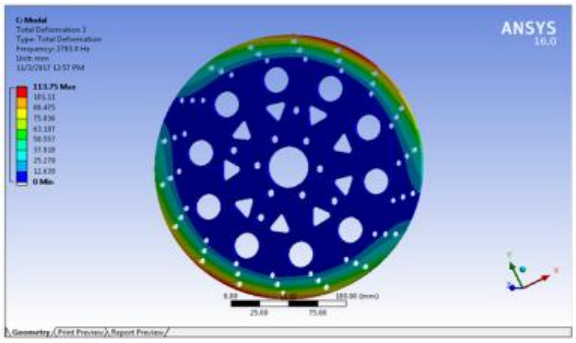


ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 4, Issue 4, April 2017

Mode6

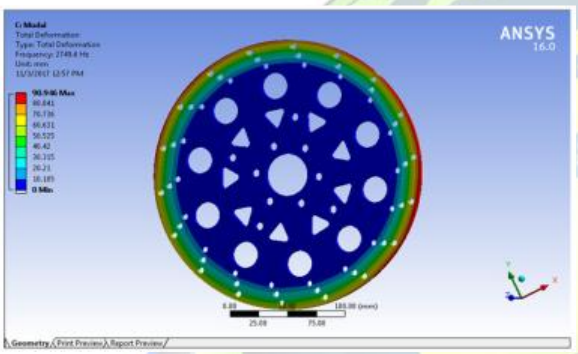


Mode3

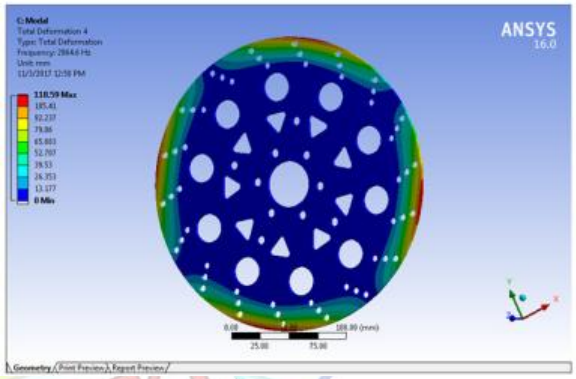


Material: Grey Cast Iron

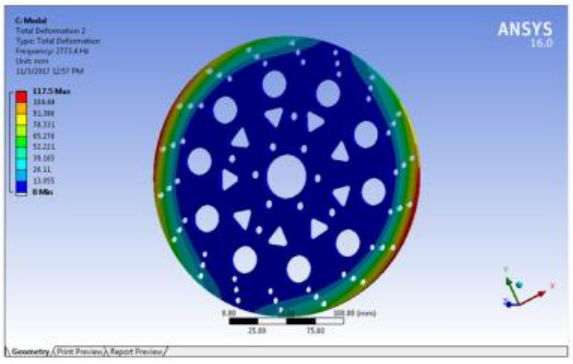
Mode1



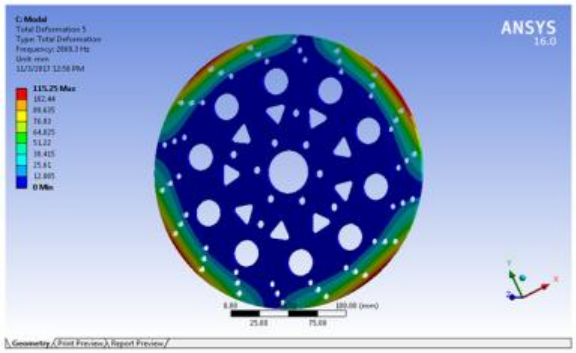
Mode4



Mode2

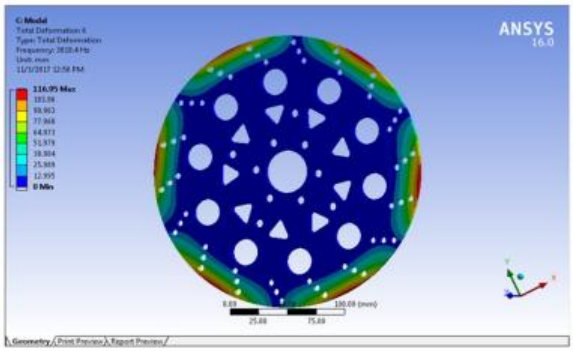


Mode5



ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 4, Issue 4, April 2017

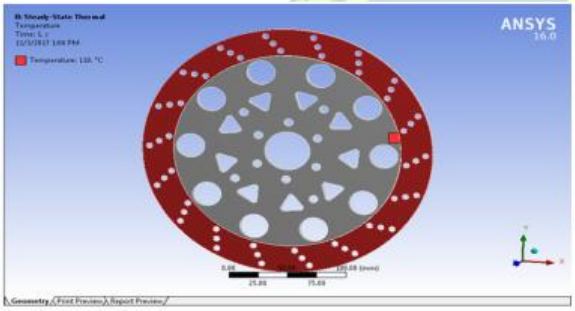
Mode6



THERMAL ANALYSIS

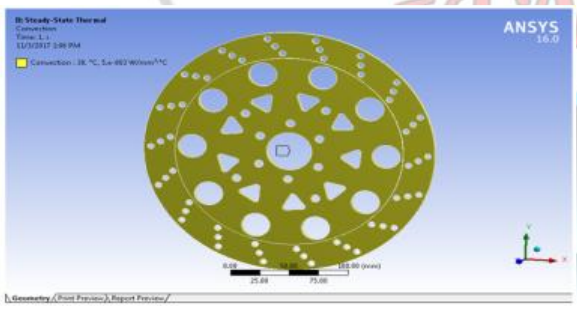
Temperature

Temperature due to friction is 110 deg C



Convection

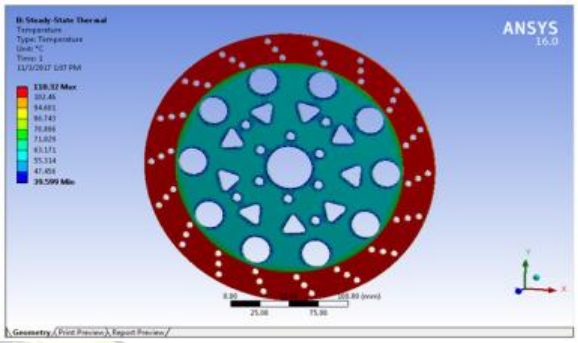
Convection at ambient temperature of 30 deg C by air



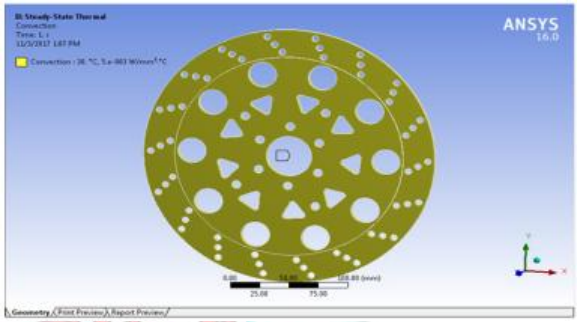
Results

Material: Hot Rolled Stainless Steel

Temperature distributions

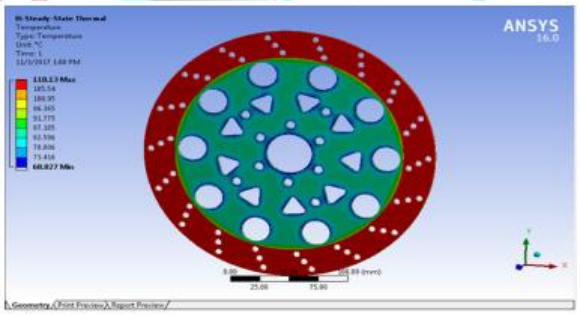


Total Heat flux



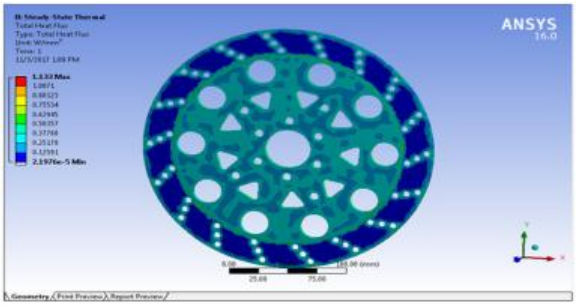
Material: Grey Cast Iron

Temperature distributions



ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 4, Issue 4, April 2017

Total Heat flux



Result tables:

Static structural analysis

Material	Stress(mpa)	Strain	Deformation(mm)
Stainless steel + Al	3.6315	1.7209e-5	0.000259
Grey Cast Iron	3.693	3.3575e-5	0.00051486

Modal analysis

	Stainless steel +AL		Grey cast iron	
Modes	Frequency (Hz)	Max Deformation (mm)	Frequency (Hz)	Max Deformation (mm)
Mode1	3646.6	86.509	2749.6	90.946
Mode2	3679.4	112.51	2773.4	117.5
Mode3	3692.9	109.04	2783.8	113.75
Mode4	3803.5	113.32	2864.6	118.59
Mode5	3809.8	110.27	2869.3	115.25
Mode6	4013.8	111.87	3019.4	116.95

Thermal analysis

Material	Temperature distribution(c)		Total Heat flux(w/mm2)	
	Max	Min	Max	Min
Stainless Steel + AL	110	39.599	0.77327	1.667e-5
Grey cast iron	110	68.827	1.133	2.1976e-5

Conclusion:

- Brief study about disc brake its applications working is studied in this project.
- By using Al+stainless steel hotrolled material machining is done and manufactured a disk brake with ventilated holes.
- Design and analysis on disc brake is done of same geometry of disc brake which is machined.
- Disc brake Model with same dimensions is made in solidworks2016 CAD software by using various tools and commands
- Solidworks cad part file of disc brake is Converted to IGES (neutral) file and transferred to ANSYS work bench software for analysis.
- Static structural analysis is performed on disc brake with two different materials such as stainless+Al hot rolled material and Grey Cast iron by applying break pressure load of 2.1mpa.
- As static structural analysis result Stress strain and deformation is noted and tabulated.
- Thermal analysis is performed by taking thermal load as 110 deg C due to brake pads friction on disc brake after applying load.
- Temperature distribution and thermal heat flux is noted and tabulated as the result.
- Modal analysis is performed on disc brake to study its dynamic conditions.
- Six Mode of deformation based upon natural working frequencies is noted and tabulated.
- From the result table of static structural analysis we can conclude that max stress value is lower thanyield tensile strength value of material hence design is safe.
- From result table we can conclude that hot rolled Stainless Steel is showing least stress and deformation value compare to generally used Grey Cast Iron.

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 4, Issue 4, April 2017

- And meanwhilefrom thermal analysis result table we can conclude that Hot rolled Stainless steel+Al is providing temperature distribution from 110 Deg C to 37.921 cooling up to 72 Deg C which is better than Grey cast iron, when the vehicle is running condition.
- Modal (dynamic) analysis result table provide the dynamic behavior of manufacture disc deformation based on frequencies for both the materials.
- Hot rolled Stainless+Al is showing high natural frequencies and respective less deformation compare to generally used grey cast iron in vehicle dynamic condition
- Hence we can conclude that manufactured disc brake with the material of Al+stainless steel hot rolled is safe and give better strength and thermal cooling effect and better dynamic behavior than generally used Grey cast iron.

References:

[1] Dr. Ramesha, Santhosh Kumar And Bharath Shekar, "design and analysis of brake drum using solidworks", 'International Journal Of Emerging Trends In Engineering And Development', 2 Vol. 3, Issn 2249-6149, Pp 281-292,2012.

[2] "Tribological Investigation Of Titanium-Based Materials For Brakes" Peter J. Blau∗, Brian C. Jolly, Jun Qu, William H. Peter, Craig A. Blue,2007.

[3] V. M. Thilak, R. KrishnaraDeepan&R.Palani, "Transient Thermal And Structural Analysis Of The Rotor Disc Of Disc Brake", International Journal Of Scientific & Engineering Research Volume 2, Issue 8, August-2011 Issn 2229-551.

[4] "Finete Element Analysis Of Disc Brake Rotor", 2014 .

[5] Christo Ananth, Kanthimathi, Krishnammal, Jeyabala, Jothi Monika, Muthu Veni, "GSM Based Automatic Electricity Billing System", International Journal Of Advanced Research Trends In Engineering And Technology (IJARTET), Volume 2, Issue 7, July 2015, pp:16-21

[6] Limpert, Rudolf "Brake Design and Safety", Society of Automotive Engineers., Inc, PA, USA, 2012

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 4, Issue 4, April 2017

AUTHORS

N.RAHUL

Email:rahul.n14311@gmail.com

PG Scholar, Department of MECH, MALLAREDDY ENGINEERING COLLEGE, HYDERABAD

Ph:9966151590/7981456576

K.SRINIVASA RAO

Email:Srinivas7727@gmail.com

Associate Professor, Department of MECH, MALLAREDDY ENGINEERING COLLEGE, HYDERABAD

Ph:9490317727