DESIGN AND ANALYSIS OF DUAL BRAKE DRUMS ON VARIOUS MATERIAL (AL6061, HIGH CARBON STEEL, MANGANESE) USING CATIA

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Abstract-A brake is a device by means of which artificial frictional resistance is applied to moving machine member, in order to stop the motion of a machine. In the process of performing this function, the brakes absorb either kinetic energy of the moving member or the potential energy given up by objects being lowered by hoists, elevators etc. The energy absorbed by brakes is dissipated in the form of heat. Disc brake is familiar automotive application where they are used extensively for car and motorcycle wheels. This is sandwiched between two pads actuated by pistons supported in a caliper mounted on the stud shaft. When the brake lever is pressed hydraulically pressurized fluid is forced into the cylinders pushing the opposing pistons and brake pads into frictional contact with the disc.Friction brakes act by generating frictional forces as two or more surfaces rub against each other. The stopping power or capacity of a friction brake depends on the area in contact and coefficient of friction of the working surfaces as well as on the actuation pressure applied. Wear occurs on the working surfaces, and the durability of a given brake depends on the type of friction material used for the replaceable surfaces of the brake. As per the outcome shown above, we can say that by substituting the usual cast iron material by other material we can decrease the stress produced in the disc brake and moreover we anticipate that by substituting the material the enhanced comfort level throughout the spring can be accomplished or in other word it concentrated the total deflection of the disc brake. Another significant characteristic is weight, which is also concentrated in case of manganese disc brake and Aluminium6061 material ,which can consequence in enhanced design of the disc brake material. The composite material accumulates up to 80% of the entire weight as compare to the usual steel material. it can be said that the current work is established that can be used for Aluminium 6061,manganese,high carbon steel, disc brake.

Keywords: Al6061,High Carbon Steel, Manganese Metal Matrix Composites, CATIA.

I. INTRODUCTION

A brake is a device by means of which artificial frictional resistance is applied to moving machine member, in order to stop the motion of a machine. In the process of performing this function, the brakes absorb either kinetic energy of the moving member or the potential energy given up by objects being lowered by hoists, elevators etc. 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 constant prolonged application.
- The brakes should have well anti wear properties.

1.1 PRINCIPLE OF BRAKES

Brakes are one of the most important control components of vehicle. They are required to slow or stop the vehicle with in the smallest possible distance and once the vehicle is stopped, to keep it from moving again, and this is done by converting the kinetic energy of the vehicle into the heat energy which is dissipated into the atmosphere.

1.2 CONSTRUCTION

There are two types of brakes are present, they are Drum and Disc brakes.

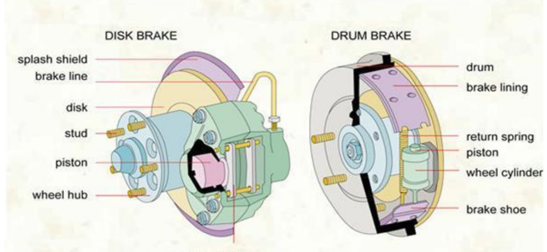


Fig 1.2.1 Construction

1.3 TYPES OF BRAKES

This criterion gives the following types of brake:

1) Mechanical brakes	2) Hydraulic brakes
3) Electrical brakes	4) Vacuum brakes
5) Air brakes	6) By-wire brakes

1.4 DISC BRAKE

A Disc brake consists of a metal disc bolted to the wheel hub and to a stationary housing called caliper. The caliper is connected to some stationary part of the vehicle, like the axle casing or the stub axle and is cast in two parts, each part containing a piston. In between each piston and the disc, there is a friction pad held in position by retaining pins, spring plates etc. passages are drilled in the caliper for the fluid to enter or leave each housing. These passages are also connected to another one for bleeding. Each cylinder contains a rubber sealing ring between the cylinder and the piston.

When the brakes are applied, hydraulically actuated pistons move the friction pads into contact with the disc, applying equal and opposite forces on the later. On releasing the brakes, the rubber sealing rings act as return springs and retract the pistons and the friction pads away from the disc.

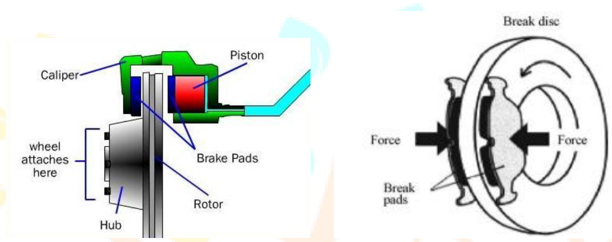


Fig 1.4.1 Disc brake

1.5 Components of Disc Brake

1.5.1 Calipers

Brake caliper is the assembly which houses the brake pads and pistons. Basically there are two types of calipers they are fixed and floating type calipers.

1.5.2 Fixed caliper

A fixed caliper does not change its position relative to the disc. It employs one or more pairs of pistons to clamp each side of the disc. Here calipers are permanently fixed one.

1.5.3 Floating Caliper

Floating caliper may further be classified as the swinging caliper type and the sliding caliper type. In swinging caliper type the caliper is hinged about a fulcrum pin and one of the friction pads is fixed to the caliper. The fluid under pressure presses the other pad against the disc to apply the brake. The reaction on the caliper causes it to move the fixed pad against the disc to apply the brake. The reaction on the caliper causes it to move the fixed pad inward slightly, applying equal pressure to the other side of the disc. The caliper automatically adjusts its position by swinging about the pin.In the sliding caliper type, there are two pistons between which the fluid under pressure is sent which presses on friction pad directly onto the disc, whereas the other pad is pressed indirectly via the caliper. Both these types are self adjusting and have resulted in simpler and lighter construction.

1.5.4 Pistons

The most common brakes use a single hydraulically-actuated piston within a cylinder in the caliper. Some high performance brakes may have as many as eight pistons. Pistons are generally made of aluminium or chrome plated iron.Some large pistons for disc brakes are made of hard plastic whereas in some other cases, these are precision ground and plates with nickel chrome which provides them with a hard surface which is durable.

1.5.5 Discs

The discs of the brakes have been conventionally made of pearlitic gray cast iron. This material is cheap and has good anti wear properties. Cast steel discs have also been employed in certain cases, which wear still less.Recently materials like ceramics and carbon fibre have also found their way into automotive brakes. The greatest advantage of these materials is the weight reduction.Two types of disc have been employed in various makes of disc brakes, i.e. the solid or the ventilated type. The ventilates type, no doubt, provides better cooling. It is seen that using a ventilated disc results in reduction of about 30% in the pad temperature, as compared to solid discs. This results in longer pad life. However, the ventilated discs also have certain disadvantages. They are usually thicker and even sometimes heavier than the solid discs.

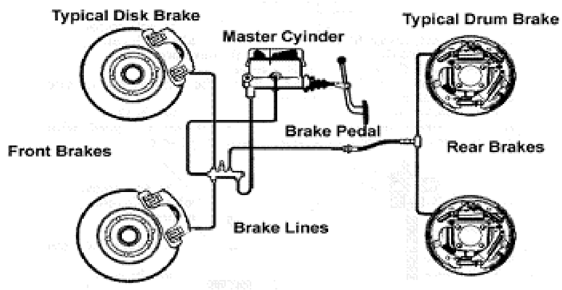
1.5.6 Brake pads

The brake pads are designed for high friction. The material for the pads is organic, semi metallic/sintered, metallic and ceramic materials.

1.6 FAILURE MODES OF DISC BRAKES

Most vehicles involved in accidents nowadays are the big vehicles. Their braking system is quite different from the small cars. They have air tanks for their braking system. Small vehicles too are hard to brake unless the engine is running. But they don't need a lot of air as the big ones. So the time the engine starts, enough air is made available to the brake system.. Running from the brake lines to the brake calipers as well as to the wheel cylinders are rubber brake hoses. It is advised to avoid their exposure to dirt, road grime, salt and other elements. These can make the rubber to become brittle and can produce crack. This will then lead to a failure in the brake system. As well, it is worth noting that brake failure can be caused by water in the brake fluid. When the fluid gets hot, the water will vaporize. This steam can be compressed unlike the water.

However, instead of the braking effort being transmitted to the wheels, it is dissipated and the car will fail to brake. So it is important not to forget changing the brake fluid at given interval.



1.5.1 'Failure of vehicles braking system'

FAILURE MODE	CHARACTERISTICS	CAUSES
Heat spotting	Heavy gouging resulting in rapid lining wear	Material rubbing against a heat spotted metal member
Crazing	Randomly oriented cracks on the friction material, resulting in a high wear rate	Overheating of the braking surface
Scoring	Grooves formed on the friction material, resulting in a reduction of life	Metal member needs regrinding
Fade	Material degrades or flows at the friction surface, resulting in a temporary loss of performance	Overheating caused by excessive braking
Metal pick-up	Metal from the mating member embedded in the lining	Unsuitable combination of materials
Grab	Lining contacting at ends only giving high servo effect and erratic performance	Incorrect radiusing of lining
Strip braking	Braking over a small strip of the rubbing path giving localized heating and preferential wear at those areas	Distortion of the brake path
Neglect	Material completely worn off the shoe reducing performance	Failure to provide required maintenance
Misalignment	Excessive grooving wear at preferential areas of lining surface	Lining not fitted correctly to the shoe platform

1.6.1 Failure modes of disc brakes

1.6 MATERIAL USED IN DICS BRAKES

Traditional material for automotive brake rotor is the cast iron. The specific gravity or density of cast iron is higher which consumes much fuel due to high inertia. Following section will describe the potential candidate materials those can be used for brake rotor application.

1.6.1 Cast Iron

Metallic iron containing more than 2% dissolved carbon within its matrix (as opposed to steel which contains less than 2%) but less than 4.5% is referred to as gray cast iron because of its characteristic color. Considering its cost, relative ease of manufacture and thermal stability, this cast iron (particularly, gray cast iron), is actually a more specialized material for brake applications particularly the material of choice for almost all automotive brake discs.

1.6.2 Titanium alloys

Titanium alloys and their composites have the potential to reduce weight of the brake rotor disc component which is about 37% less than a conventional cast iron with the same dimensions and offering good high temperature strength and better resistance to corrosion.

1.6.3 Aluminium-Metal Matrix Composite (AMC)

Aluminium alloy based metal matrix composites (MMCs) with ceramic particulate reinforcement have shown great promise for brake rotor applications. These materials having a lower density and higher thermal conductivity as compared to the conventionally used gray cast irons are expected to result in weight reduction of up to 50-60% in brake systems. The repeated braking of the AMC brake rotor lowered the friction coefficient μ and caused significant wear of the brake pad. The friction properties of the AMC brake disc are thus remarkable poorer than those of conventional brake disc.

Based on the properties, potential candidate materials for automotive brake disc were selected as:

- Gray cast iron (GCI)
- Ti-alloy (Ti-6Al-4V)
- 7.5 wt% WC and 7.5 wt% TiC reinforced
- Ti-composite (TMC)
- 20% SiC reinforced Al-composite (AMC 1)

- 20% SiC reinforced Al-Cu alloy (AMC 2)
- ***1.7 MATERIAL PROPERTIES:***

1.7.1 The Material Properties of Cast Iron:

Thermal co-efficient of expansion (Kxx) = 1.7039e-5 /°C
Thermal conductivity (K) = 54.0 W / m k
Specific heat (Cp) = 586.0 J/Kg k
Density of cast iron (ρ) = 7100 kg/m3
Young's Modulus (E) = 125e9 N/m2
Poisson's ratio (υ) = 0.25

1.7.2 The Material Properties of Stainless Steel:
(Stainless Steel 302 Annealed)

Density of Stainless Steel (ρ) = 7860 kg / m3
Thermal conductivity (k) = 16.2 Watts / m k
Specific heat (Cp) = 500 J / kg k
Young's Modulus (E) = 193e9 N / m2
Poisson's ratio (ν) = 0.29
Coefficient of Thermal Expansion (Kxx) = 1.72e-5 m/m °C

1.7.3 The Material Properties of Aluminum:
(Aluminum 2014-T6)

Density of Aluminum (ρ) = 2800 kg / m3
Thermal conductivity (k) = 155 Watts / m k
Specific heat (Cp) = 880 J / kg k
Young's Modulus (E) = 72.4e9 N / m2
Poisson's ratio (ν) = 0.33 Coefficient of Thermal Expansion (Kxx) = 2.3e-5 m/m °C

Table1.7.3 properties of materials

Properties of candidate materials for brake disc [11, 13]

Properties / Material	1 Compressive Strength (MPa)	2 Friction coefficient (μ)	3 Wear rate ($x10^{-6}$ $mm^3/N/m$)	4 Specific heat, Cp (KJ/Kg . K)	5 Specific gravity (Mg/m^3)
GCI	1293	0.41	2.36	0.46	7.2
Ti-6Al-4V	1070	0.34	246.3	0.58	4.42
TMC	1300	0.31	8.19	0.51	4.68
AMC 1	406	0.35	3.25	0.98	2.7
AMC 2	761	0.44	2.91	0.92	2.8

Scaled Properties						
	1	2	3	4	5	Performance Index (γ)
GCI	99	93	100	47	38	81.0
Ti-6Al-4V	82	77	0.96	59	61	49.5
TMC	100	70	29	52	58	56.0
AMC 1	31	80	73	100	100	79.0
AMC 2	59	100	81	94	96	88.6

1.7.4 The Materials used for the manufacturing process.

- In earlier days, these brake discs were made straight from the moltenbrittle ceramic materials but researchers have found that short carbon fibers would be a solution for the brittleness of ceramic materials and hence for the manufacturing of the discs, following materials are used:
  - Short carbon fibers
  - Carbon powder
  - Heat molded resin
- Then at the time of when the brake disc shape is obtained by heating the mixture of above materials and cooling down, another ceramic material known as silicon is added to harden the brake disc, forming a new material called silicon carbide.
- The above mentioned heat molded resin is a material that binds all other materials together in that mixture of the brake disc, and once this material is hardened by molding, it can't be softened by any process.

II. PROBLEM DISCRIBTION

Friction brakes act by generating frictional forces as two or more surfaces rub against each other. The stopping power or capacity of a friction brake depends on the area in contact and coefficient of friction of the working surfaces as well as on the actuation pressure applied. Wear occurs on the working surfaces, and the durability of a given brake (or service life between maintenance) depends on the type of friction material used for the replaceable surfaces of the brake.

If drake disc are in solid body the Heat transfer rate is low. Time taken for cooling the disc is low. If brake disc are in solid body, the area of contact between Disc and Pads are more, so efficiency of brake is high.We introduced superimpose variation cut pattern on the disc in disc brake. The number of cuts Pattern introduce in disc The Heat transfer rate is increase. Time taken for cooling the disc is high. If the number of cut is increase in the disc, the area of contract between the disc and pads were reduces, so efficiency of brake is high. The number of cut was increase the strength of the disc also reduces. So it can easily break. So the number of cuts in the disc with in the limit, It can help to Heat transfer rate of the disc and the area of contact between Disc and Pads are not reduces and efficiency of brake must be same.

2.1 MODEL DIAGRAM

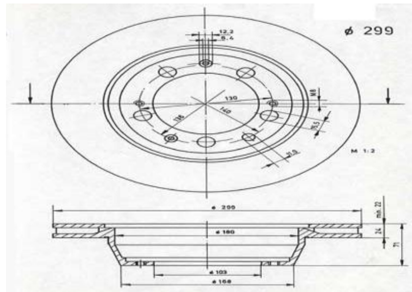


Figure.2.1MODEL DIAGRAM

2.2 INTRODUCTION TO CATIA

CATIA V5 is mechanical design software, addressing advanced process centric design requirements of the mechanical industry. With its feature based design solutions, CATIA proved to be highly productive for mechanical assemblies and drawing generation. CATIA with its broad range of integrated solutions for all manufacturing organization. CATIA is the best solution capable of addressing the complete product development process, from product concept specification through product service in a fully integrated and associative manner. CATIA mechanical design solutions provide tools to help you implement a sophisticated standard based architecture. This enables collaborative design and offers digital mockups and hybrid deigns.

The domain includes-

- Product design & manufacturing.
- Drawing enterprise competitiveness
- Task presentation
- Process improvement.

CATIA V5 P3 users access the highest productivity for specific advanced processes with focused solutions. They can lead expert engineering and advainnovation, relying on unique and very specialized that integrates product and process expertise.

- SKETCHER
- PART DESIGN
- ASSEMBLY DESIGN
- WIREFRAME AND SURFACE DESIGN
- DRAFTING
- REAL

2.2.1 PART DESIGN

CATIA sketcher tools initially drafts a rough sketch following the shape of the profile. The objects created are converted into a proper sketch by applying geometric constraints and dimensional constraints. These constraints refine the sketch according to a rule. Adding parametric dimensions further control the shape and size of the feature. Pad, groove, slot etc., are used as one of the feature creation tools to convert the sketcher entity into a part.

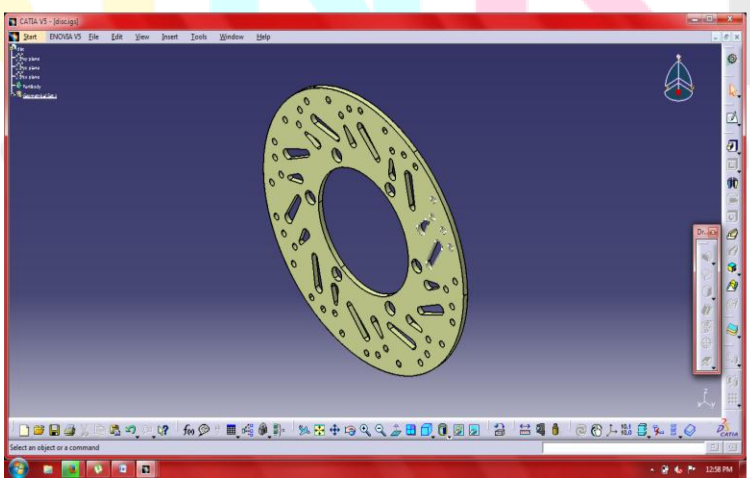


Fig 2.2 Part design

2.2.3 DRAWING DETAILS

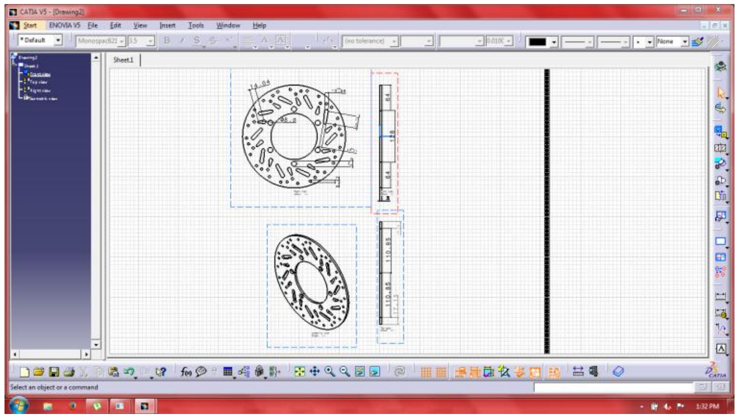


Fig 2.3 drawing details

2.3 FORCE FLOW DIAGRAM OF PROBLEM

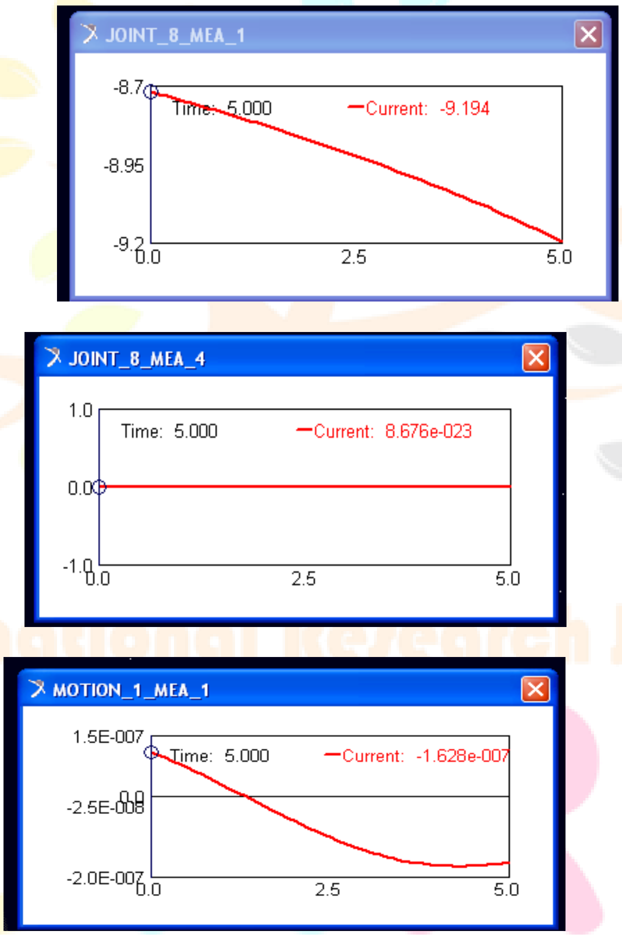


Fig 2.4 FORCE FLOW DIAGRAM OF PROBLEM

2.4 DESIGN CALCULATIONS FOR DISC

Disc Brake Calculations:

Given Data:

Velocity of the vehicle = 70 m.p.h = 112.65408 kmph = 31.2928 m/s

Time for stopping the vehicle = 4 seconds

Mass of the vehicle = 143 kg.

Step-1:

Kinetic Energy (K.E) = ½ * m * υ2 = ½ * 143 * 31.29282^2 = 70012.032 Joules

The above said is the Total Kinetic Energy induced while the vehicle is under motion.

Step-2:

The total kinetic energy = the heat generated

Qg = 70012.032 Joules

Step-3:
The area of the rubbing faces A = Π * (0.1802 – 0.10362) = 0.068069 m^2
Step-4:
Heat Flux = Heat Generated / Second / rubbing area
= 70012.032 / 4 /0.068069
= 1050.018Watts / m^2
The analysis is done by taking the distribution of braking torque between the front and rear axle is 70:30
Thus Heat Flux on each front wheel = (1050.018 * 0.7)/2 =367.563 Watts / m^2
For 5 Seconds of Breaking: Heat Flux = Heat Generated / Second / rubbing area
= 70012.032 / 5 /0.068069
= 840 Watts / m^2
The analysis is done by taking the distribution of braking torque between the front and rear axle is 70:30
Thus Heat Flux on each front wheel
= (840 * 0.7)/2 =294 Watts / m^2
For 6 Seconds of Breaking:
Heat Flux = Heat Generated / Second / rubbing area
= 70012.032 / 6 /0.068069
= 700 Watts / m^2
The analysis is done by taking the distribution of braking torque between the front and rear axle is 70:30
Thus Heat Flux on each front wheel
= (700 * 0.7)/^{2}
=245 Watts / m^2

2.4.1 BRAKE

Material: GREY cast iron (modulus of rigidity) G = 1.6e10
Mean dia of a disc r1=128mm.
dia of hole r =6mm
Total no of holes n1= 45
Inner diameter of disc r0 = r1 -r =57.5mm
No of active turns n= 20
Weight of bike = 143kg
Rear disc = 65%
65% of 143 = 92.5kgs
Considering dynamic loads it will be double W = 100Kgs = 981N
Joint force=9.194N
Displacement=5.551e4
Acceleration=8.676e23
Poisson's Ratio = 0.28
Modulus of elasticity = 1.6. E 10 N/m^2

2.4.2 LOAD CARRYING FORCES ARE DETERMINED BY USING ADAMS

In kinematics and dynamics of machinery, were kinematics involves in finding out the results of body in motion without considering the forces and dynamics involves in finding the result of the body in motion with considering the forces. These analyses are carried out by graphical, analytical and numerical method. The choice of approach to the solution is depend on the problem at hand and the available data.In general mechanisms are used to obtain various types of motion, one of the motion is intermittent motion, to obtain the intermittent motion various type of mechanisms are used out of which cam mechanism provides the best intermittent motion is been explained in the Adams by comparing the advantage of cam over the other mechanism. The wiper function is based on four bar mechanism were to obtain the crank rocker motion synthesis of link length is carried out and modeled in ADAMS 2010 motion & constrains are provided the result of displacement, velocity & acceleration is taken and the effect of change in result by changing the crank length and coupler length is funded and the results were compared and analyzed. The bearings are used to support the rotating shafts at the ends for the selection of the bearing the force on the bearing is required. In the given mass, radius & rpm the shape is modeled in ADAMS and the force acting on the bearing was found and by changing the parameters of mass, radius and rpm the effect of change in the result was found and it is compared and analyzed.
Data value found from the Adams software,Motion acting in the disc= 980N,Because the force applied to both pad of the disc are fully transmitted to disc.

III.DESIGN ANALYSIS

Finite Element Analysis (FEA) was first developed in 1943 by R. Courant, who utilized the Ritz method of numerical analysis and minimization of variational calculus to obtain approximate solutions to vibration systems. Shortly thereafter, a paper published in 1956 by M. J. Turner, R. W. Clough, H. C. Martin, and L. J. Top established a broader definition of numerical analysis. The paper centered on the "stiffness and deflection of complex structures". By the early 70's, FEA was limited to expensive mainframe computers generally owned by the aeronautics, automotive, defense, and nuclear industries. Since the rapid decline in the cost of computers and the phenomenal increase in computing power, FEA has been developed to an incredible precision. Present day supercomputers are now able to produce accurate results for all kinds of parameters. FEA consists of a computer model of a material or design that is stressed and analyzed for specific results. It is used in new product design, and existing product refinement. A company is able to verify a proposed design will be able to perform to the client's specifications prior to manufacturing or construction. Modifying an existing product or structure is utilized to qualify the product or structure for a new service condition. In case of structural failure, FEA may be used to help determine the design modifications to meet the new condition. There are generally two types of analysis that are used in industry: 2-D modeling, and 3-D modeling. While 2-D modeling conserves simplicity and allows the analysis to be run on a relatively normal computer, it tends to yield less accurate results. 3-D modeling, however, produces more accurate results while sacrificing the ability to run on all but the fastest computers effectively. Within each of these modeling schemes, the programmer can insert numerous algorithms (functions) which may make the system behave linearly or non-linearly. Linear systems are far less complex and generally do not take into account plastic deformation. Non-linear systems do account for plastic deformation, and many also are capable of testing a material all the way to fracture.FEA uses a complex system of points called nodes which make a grid called a mesh. This mesh is programmed to contain the material and structural properties which define how the structure will react to certain loading conditions. Nodes are assigned at a certain density throughout the material depending on the anticipated stress levels of a particular area.Regions which will receive large amounts of stress usually have a higher node density than those which experience little or no stress. Points of interest may consist of: fracture point of previously tested material, fillets, corners, complex detail, and high stress areas. The mesh acts like a spider web in that from each node, there extends a mesh element to each of the adjacent nodes. This web of vectors is what carries the material properties to the object, creating many elements.

A wide range of objective functions (variables within the system) are available for minimization:

- Mass, volume, temperature
- Strain energy, stress strain
- Force, displacement, velocity, acceleration
- Synthetic (User defined)

There are multiple loading conditions which may be applied to a system. Some examples are shown:

- Point, pressure, thermal, gravity, and centrifugal static loads
- Thermal loads from solution of heat transfer analysis
- Enforced displacements
- Heat flux and convection
- Point, pressure and gravity dynamic loads

Each FEA program may co me with an element library, or one is constructed over time. Some sample elements are:

- Rod elements & Beam elements
- Plate/Shell/Composite elements
- Shear panel
- Solid elements
- Spring elements
- Mass elements
- Rigid elements
- Viscous damping elements

Many FEA programs also are equipped with the capability to use multiple materials with in the structure such as:

- Isotropic, identical throughout
- Orthotr opic, identical at 90 degrees
- General anisotropic, different throughout

3.1 GENERIC STEPS TO SOLVING ANY PROBLEM IN ANSYS:

Build Geometry

Construct a three dimensional representation of the object to be modeled and tested using the work plane coordinates system within ANSYS

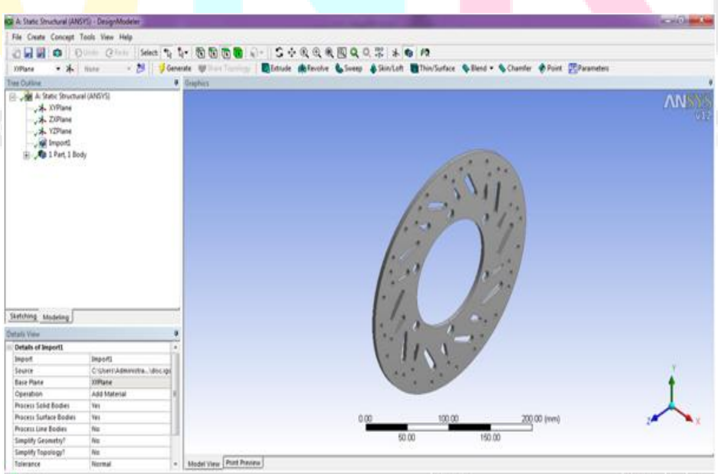


Fig 3.1 Build Geometry

3.2 Define Material Properties

Now that the part exists, define a library of the necessary materials that compose the object (or project) being modeled. This includes thermal and mechanical properties. Here the material selected is cast iron, manganese, high carbon steel, and al6061 so we take material properties values are ,

NO	MATERIAL	YOUNG MODULUS (GPa)	POISSON RATIO	DENSITY (kg/m^3)
1	GREY CAST IRON(CURRENT)	167	0.29	7350
2	HIGH CARBON STEEL	235	0.31	8260
3	AL6061	73	0.22	2850
4	MAGANESE	159	0.35	7100

3.3 Selection of element type SOLID 185

SOLID 185 is used for 3-D modeling of solid structures. It is defined by eight nodes having three degrees of freedom at each node: translations in the nodal x, y, and z directions. The element has plasticity, hyper elasticity, stress stiffening, creep, large deflection, and large strain capabilities. It also has mixed formulation capability for simulating deformations of nearly incompressible elasto plastic materials, and fully incompressible hyper elastic materials

3.4 Generate Mesh

At this point ANSYS understands the makeup of the part. Now define how the Modeled system should be broken down into finite pieces. In a spring design we had done **free** mesh to meshing model.

3.5 Selection of free mesh

Smart element sizing (Smart Sizing) is a meshing feature that creates initial element sizes for **free** meshing operations. Smart Sizing gives the meshes a better chance of creating reasonably shaped elements during automatic mesh generation. This feature, which is controlled by the **SMRTSIZE** command, provides a range of settings (from coarse to fine mesh) for meshing both h-Method and p-Method models.

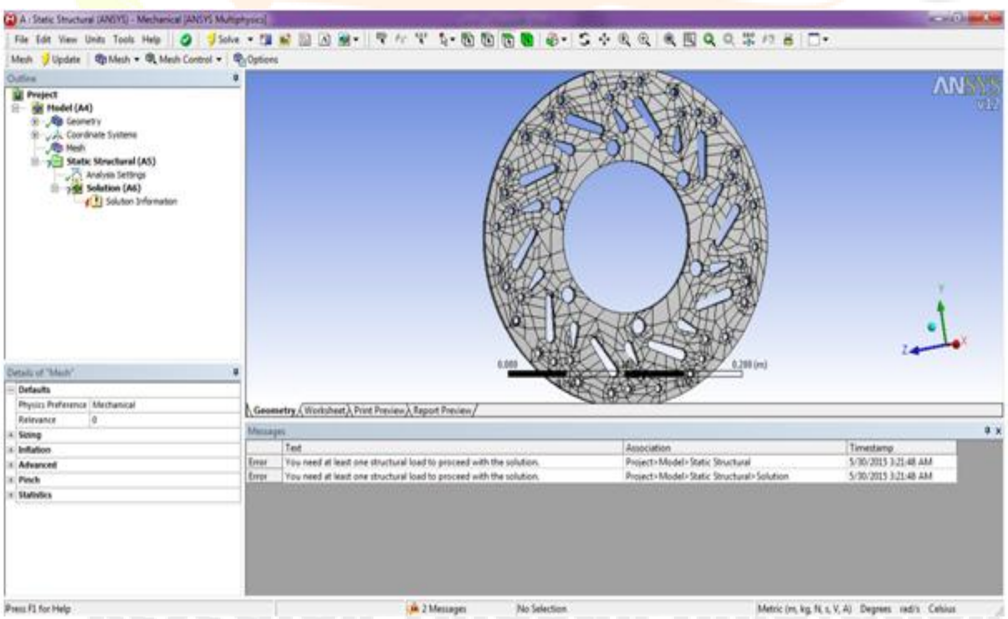


Fig 3.2 Free mesh

3.6 Apply Loads

Once the system is fully designed, the last task is to burden the system with constraints, such as physical loadings or boundary conditions. As this disc is used in the rear suspension it is necessary to find out the load acting on the disc in actual practice in static condition as well as in dynamic condition. Normally total weight of the vehicle with driver and one passenger is about 143 Kg, but for safer side it is taken as 140Kg concentrated at the center of gravity of the vehicle. It is assumed that this total weight is equally divided into two springs of rear suspension and one spring of front suspension. So the rear suspension spring is experiencing approximately 70 Kg load. This load is modeled in the analysis with the help of mass element. Then rigid body constraint equations are applied for giving contact between this element and the surface elements of the DISC on upper side.

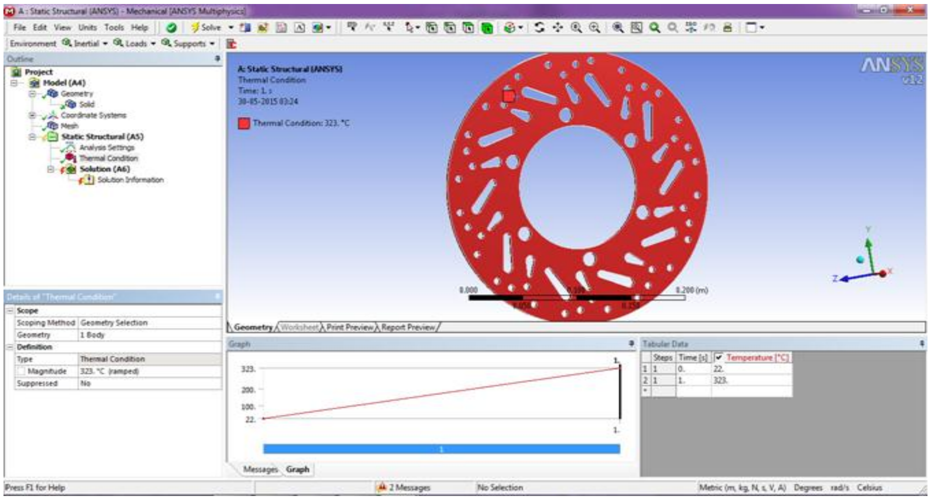


Fig 3.3 Temperature

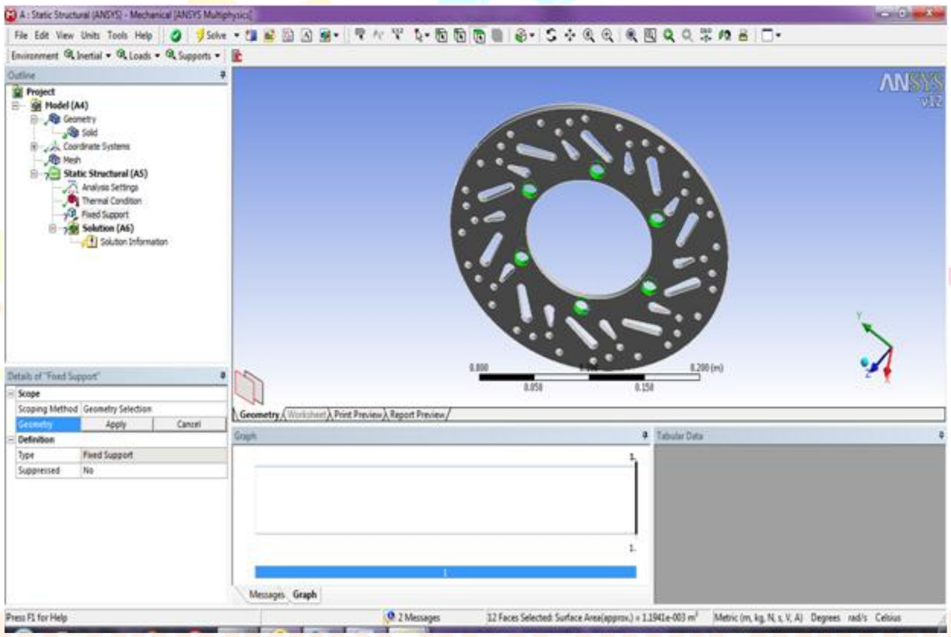


Fig 3.4 Fixed Condition

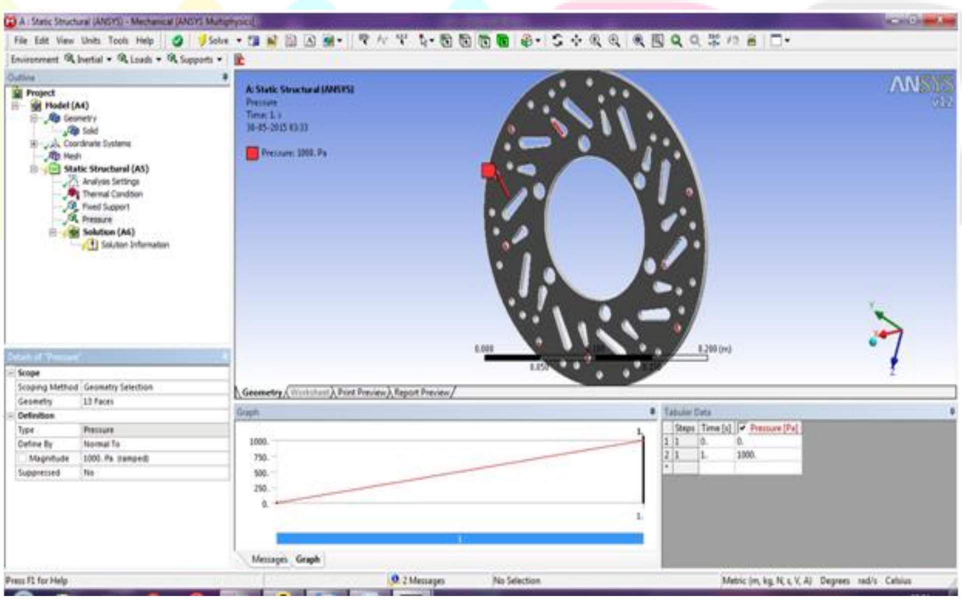


Fig 3.5 Apply Pressure

3.7 Stress analysis

After providing the material to the model, meshing and loading as well as boundary condition now we have to solve the design space created for the four disc brake models and then perform the assessment for the selection of the better material. The comparison is based on the material weight, the maximum von-misses stress, shear stress generation and the value of maximum total deformation. The results of von-misses stresses for four the materials are shown in fig.This is actually a step, because ANSYS needs to understand within what state (steady state, transient… etc.) the problem must be solved. The linear static analysis was performed to determine the stress and strain results from the finite element model. The material utilized in this work consists of a linear elastic, isotropic material. The choice of the linear elastic material model is essentially mandated. Model loading consist of the applied mechanical load, which is modeled as the load control and the displacement control. From the analysis, the inner side of the coil is found to experience the largest stresses. Von-misses and shear stress distribution of the disc is shown in figure.

VON-MISES STRESS

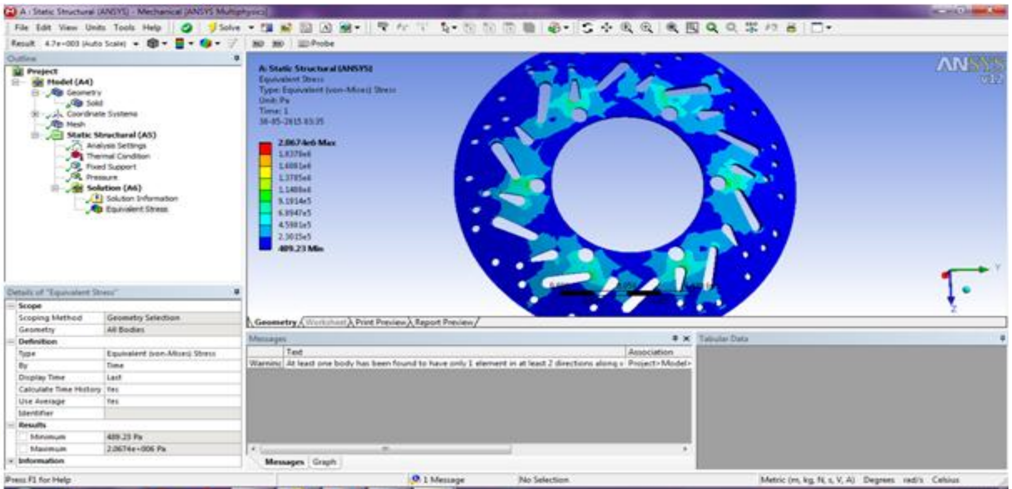


Fig 3.6 MATERIAL AL6061

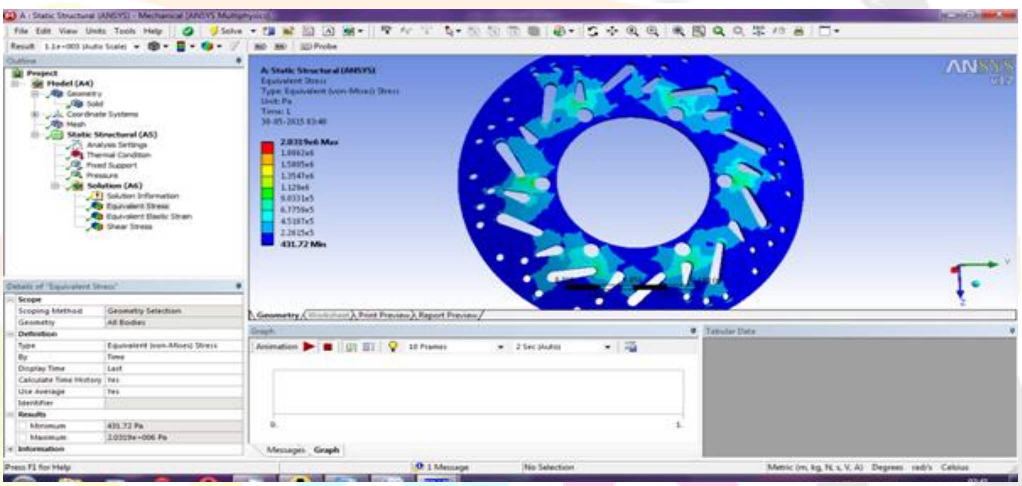


Fig 3.7 GREY CAST IRON

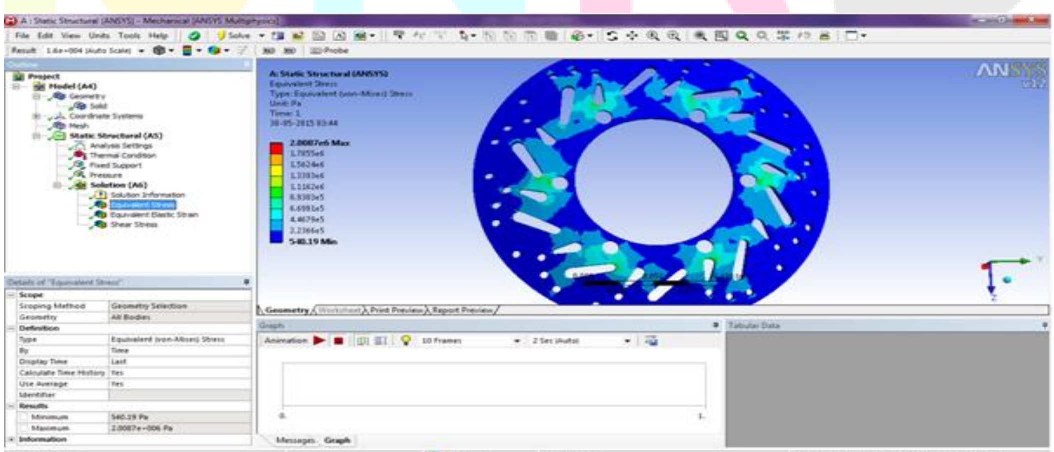


Fig 3.8 HIGH CARBON STEEL

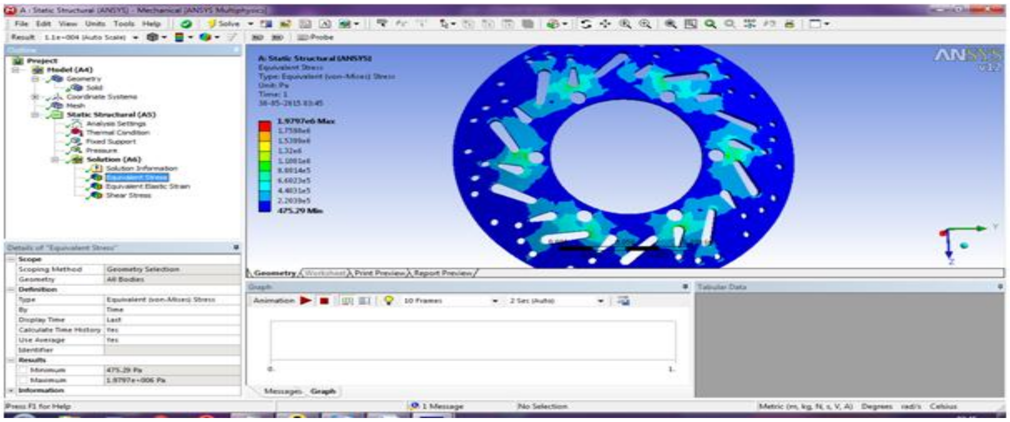


Fig 3.9 MAGANESE

SHEAR STRESS

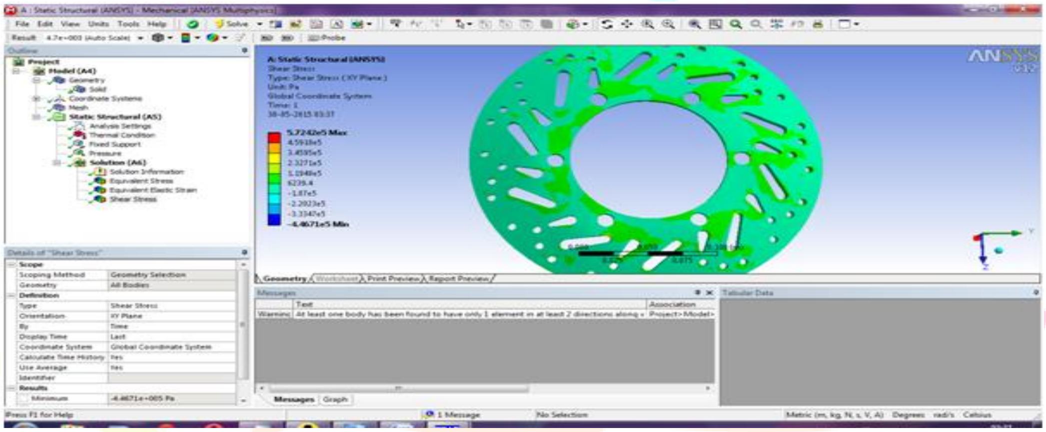


Fig 3.10 AL6061

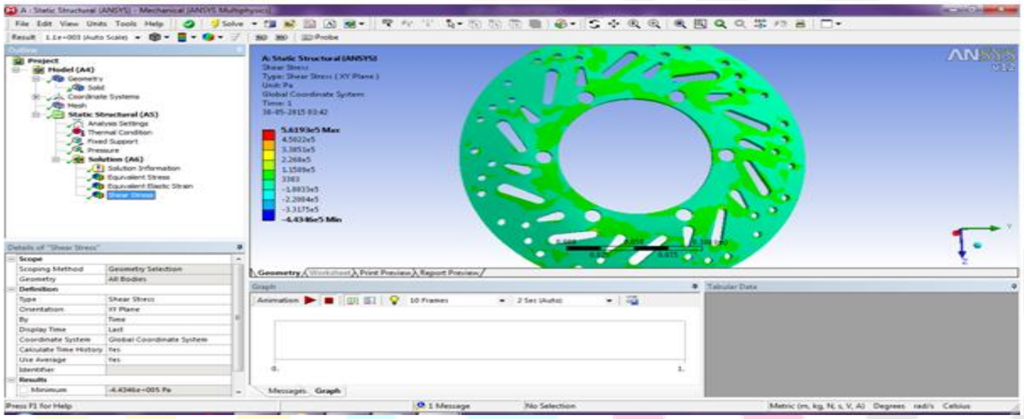


Fig 3.11 GREY CAST IRON

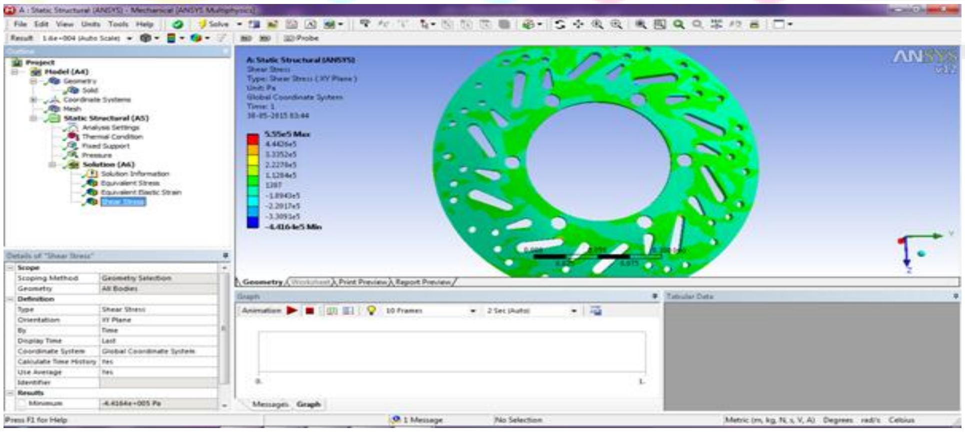


Fig 3.12 HIGH CARBON STEEL

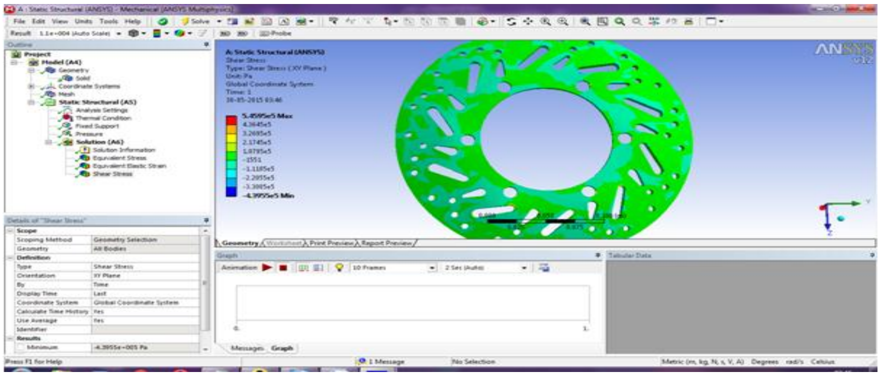


Fig 3.13 MAGANESE

TOTAL DEFORMATION

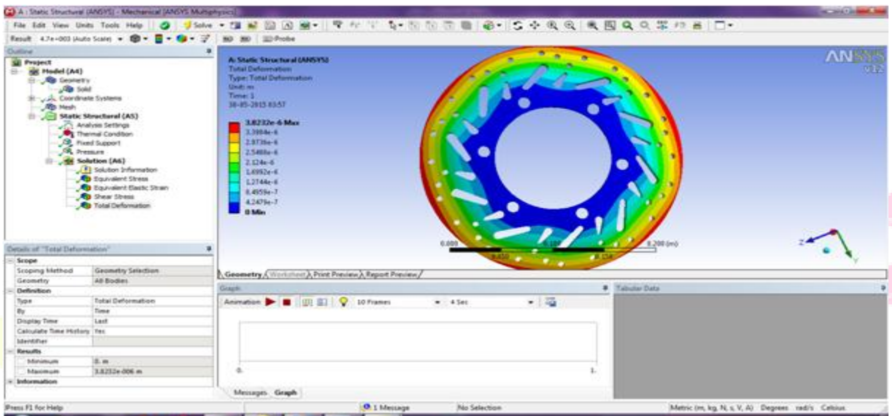


Fig 3.14 AL6061

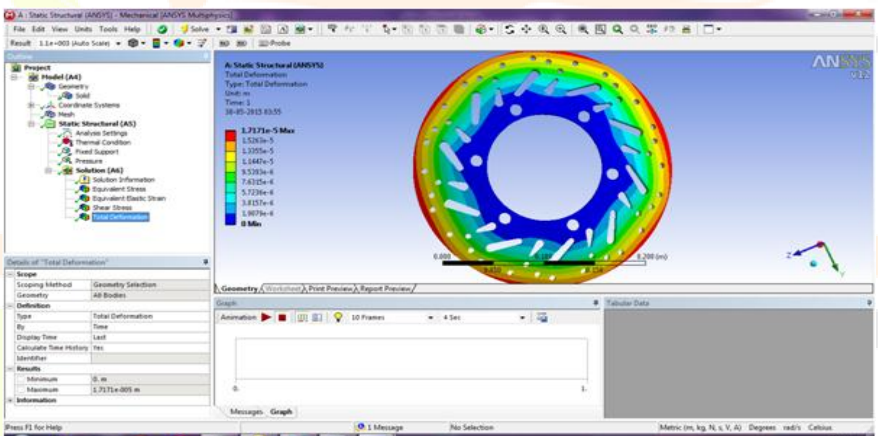


Fig 3.15 GREY CAST IRON

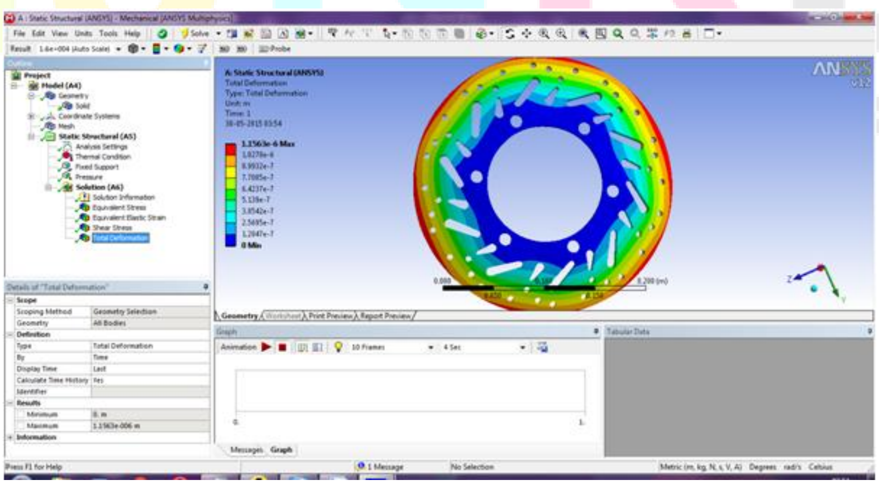


Fig 3.16 HIGH CARBON STEEL

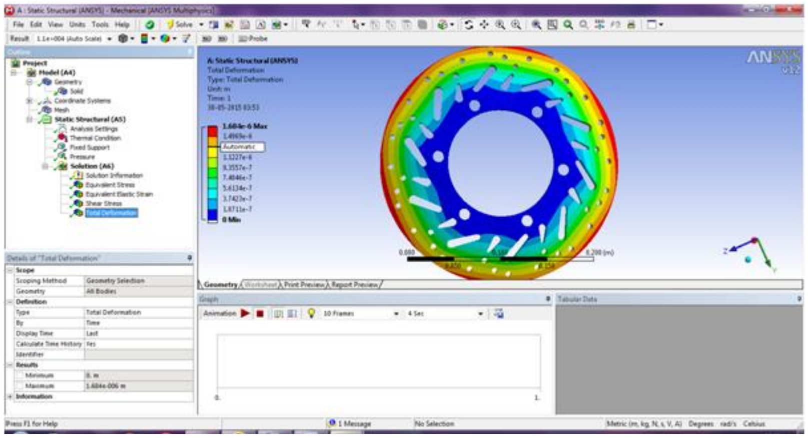


Fig 3.17 MAGANESE

V.DESIGN OF OPTIMIMIZATION

4.1 Introduction to Design Optimization

The optimization module (**/OPT**) is an integral part of the ANSYS program that can be employed to determine the optimum design and best material. This optimum design is the best material in some predefined sense. Among many examples, the optimum material for a frame structure may be the one with minimum weight or maximum frequency; in heat transfer, the minimum temperature; or in magnetic motor design, the maximum peak torque.

V.RESULT AND CONCLUSION

5.1 RESULTS FROM ANALYSIS

As presented above, we discussed the modeling and analyses of the conventional cast iron and three other material model disc brakes with the same loading and boundary conditions. The results of the analyses are shown in the previous chapter. The results are tabulated in the table

PARAMETER	CAST IRON	HIGH CARBON STEEL	AL6061	MAGANESE
VON-MISES STRESS(Pa)	2.0319e6	2.0087e6	2.067e6	1.97e6
SHEAR STRESS(Pa)	5.61e5	5.55e5	5.72e5	5.45e5
TOTAL DEFORMATION (m)	1.71e-5	1.156e-6	3.82e-6	1.68e-6

Through the comparative assessment of cast iron and three material disc brake the maximum total deflection is reduced by 78% through manganese material, Von-Misses stress generation is reduced by 20% and the weight is also reduced by 20% by using the manganese prepare disc brake.

5.2 Conclusion

The braking and energy storage processes compose an important technical question to obtain better Performance for hybrid vehicles, avoiding the loss of energy as heat and making the process of safer and more efficient braking using for example regenerative systems as flywheel. The use of techniques based on design methodology can be lead technical approaches with more innovation and improvement of present characteristics. In this work, the informational design allows the identification of the specific user requirements for a brake system. From these components were identify a set of variables that can affect the temperature on the brake pad during the braking process. As shown in the project, we confer a relative study for a variety of materials of disc brake. As per the outcome shown above, we can say that by substituting the usual cast iron material by other material we can decrease the stress produced in the disc brake and moreover we anticipate that by substituting the material the enhanced comfort level throughout the spring can be accomplished or in other word it concentrated the total deflection of the disc brake. Another significant characteristic is weight, which is also concentrated in case of manganese disc brake, which can consequence in enhanced design of the disc brake material. The composite material accumulates up to 80% of the entire weight as compare to the usual steel material. So as conclusion it can be said that the current work is established that manganese can be used for disc brake for light weight vehicles and convene the necessities, along with considerable weight reductions. By the reduction of weight and the less stresses, the fatigue life of manganese disc brake is to be higher than that of cast iron disc brake. In totally it is found that the manganese disc brake is the better that of cast iron disc brake. Which means the proposed new (manganese) material can be used to satisfy the objective.

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