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Finite Element Analysis Of Disc Brake By ANSYS Workbench

Abhishek Kumar Tiwari[1], Akhilesh Kumar Tiwari[2],Pramod Yadav[3], Harigovind Singh Yadav[4], Shyam Bihari Lal[5]

[1,2,3,4]B .Tech students, [5]Assistant Professor, Department of Mechanical Engineering,
Buddha Institute of Technology, GIDA Gorakhpur, India.

ABSTRACT
The brakes must be strong enough to stop the vehicle within a minimum distance in an emergency. The driver must have proper control over the vehicle during emergency braking and vehicle must not skid. The brakes must have good antedate characteristics their effectiveness should not decrease with prolonged application and thus it demand that the cooling of the brakes should be very efficient. For the analyses are carried out for structural steel is used with two cyclic braking conditions to find structural steel material of the disc brakes is carried out for study to structural analysis of disc brake.
The aim of this paper was to investigate the structural fields of the solid disc brake during short and emergency braking with structural material. We will take down the value of friction contact power nodal displacement and deformation for different pressure condition using analysis software with the value at the hand we can determine the best suitable material for the disc brake with higher life span.
Transient structural analysis of the rotor disc of disc brake is aimed at investigation in to usage of structural steel materials is required which improve braking efficiency and provide greater stability to vehicle. This investigation can be done using WOR BENCH software ANSYS 14.0 is a dedicated finite element package used for determining the variation of the stresses and deformation across the disc brake profile.
In the present work an attempt has been made to investigate the suitable hybrid composite material which is lighter than the cast iron and has good Young's modulus Yield strength and density properties. Hence the brake Disc design is safe based on the strength and rigidity criteria. By identifying the true design features the extended service life and long term stability is assured.

KEYWORDS: pro/E (5) Ansys work bench 14.0 structural analysis.

1. Introduction

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 disc brake is usually made of structural steel, but may in some cases be made of composition such as reinforced carbón-carbon or ceramic matrix composition. This is associated to the Wheel or the axle. To stop the wheel, frictional material in the form of brake pads, mounted on a device called a brake caliper, is forced mechanically, hydraulically, pneumatically or electromagnetically against both sides of the disc. Frictional causes the disc and attachment wheel to slower or Stopes. Brakes convert motion to heat, and if the brakes get too hot, they become less effective, a phenomenally known as brake fade. [1]

Disc brake consistence of a structural steel disc bolted to the wheel hub and a stationery housing called caliper. The caliper is connected to some stationery part of the vehicle like the axle casing or the stub axle as is cast in two parts each part containing a piston. In between each piston and the disc there is a frictional pad held in position by retainment pins, spring plates. The passages are so connected to another one for bleeding. Each cylinder contains rubber-sealing ring between the cylinder and piston. A schematically diagram is shown in the figure. Due to the application of brakes on the car disc brake rotor, heat generation takes place due to frictional and this temperature so generated has to be conducted and dispersedly across the disc rotor cross section. An investigational into usage of new materials is required which improve braking efficiency and provide greater stabilization to vehicle. [2]

Disc style brakes developmental and use began in England in the 1890s. The first caliper-type automobile disc brake was patentable by Frederick William Lanchester in his Birmingham, UK factory in 1902 and used successfully on Lanchester cars. compare to drum brakes, disc brakes offer better stopping operation, because the disc is more promptly cooled. As a aftermath discs are less prostrate to the "brake fade"; and disc brakes retrieve more quickly from submersion (wet brakes are less effective). Most drum brake designs have at least one leading shoe, which gives a servoeffect. By demarcation, a disc brake has no self-servo effect and its braking force is always relative to the pressure placed on the brake pad by the braking system via any brake servo, braking pedal or lever, this tends to afford the driver amend "feel" to avoid approaching lockup. Drums are also prostrate to "bell mouthing", and ambuscade worn lining material within the assembly, both causes of various braking troubles. [3]

The friction surface is invariably displayed to the air, checking good heat dissipation, minimizing brake fade. It also allows for self-cleaning as dust and water is thrown off, diluting friction difference.

Unlike drum brakes, disc brakes have limited self-energizing action making it necessary to apply greater hydraulic pressure to find enough braking force. This is achieved by increasing the size of the caliper piston. The simple design helps easy maintenance and pad replacement. [4]

During the braking action, the kinetic energy developed at the wheel is translated into heat energy, which doesn't break up fast plenty into the air stream from the brake to the brake disk; as a result, the thermal conductivity plays a critical role in handling such heat generated. Thermal judder, which is a result of non-uniform contact cycles between the pad and the disk brake rotor, which is mainly an effect of the placed Thermo-Elastic imbalances (TEI) at the disk brake rotor surface. placed TEI act at the friction ring surface generating intermittent hot bands around the rubbing path which may in turn leads to the growth of so-called hot spots.

In this paper a case study about a transient analysis of the thermoelastic problem for disk brakes with frictional heat generation, did using the finite element analysis (FEA) method is reported in details. The computational results are presented for the dispersion of the temperature on the friction surface between the contacting bodies (the disk and the pad). [5]

2. Material Properties for Disc Brakes

Structural Steel:

The structural steel includes a broad variety of low carbon and manganese steels. Structural steels also include minor quantities of significant additions of other elements like Nb, V, Ti and Al. These are called High Strength Low Alloy or micro-alloyed steels.

Table.1 Material property of structural steel

Name	Structural steel
Model type	Linear Elastic Isotropic
Default Failure Criterion	Max von Mises Stress
Yield Strength	1.72339e+0.008 N/m2
Tensile Strength	4.13613e+0.008 N/m2
Elastic Modulus	2e+011 N/m2
Poisson's Ratio	0.28
Mass Density	7800 kg/m3
Shear Modulus	7.7e+010 N/m2

The reinforcement in AMCs could be in the form of continuous or discontinuous fibers, whisker or particulates, in volume fractions ranging from a few percent to 70%. In the last few years, AMCs have been applied in high-tech structural and functional applications including aerospace, defense, automotive, and thermal management areas, as well as in sports and recreation. [6]

3.1 Methodology

3.1.1 Procedure of static analysis

First of all, we have prepared assembly in Pro/E for crankshaft and save as this part as IGES for Exporting into ANSYS workbench Environment. Import IGES mode in ANSYS workbench simulation module.
Apply material for Crank Shaft (structural steel).

3.1.2 Meshing criteria

Element type solid10 node quadratic tetrahedral

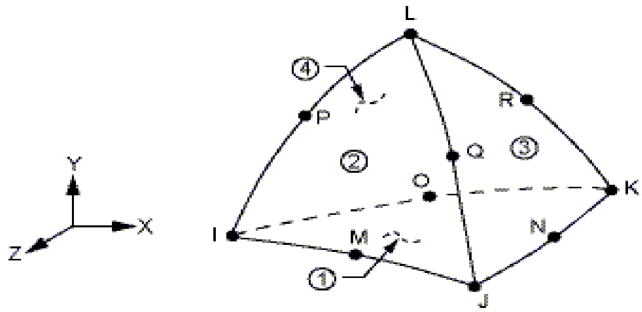

Figure 1: The 10 – node tetragonal elements (SOLID 187)

Pro/E and ANSYS workbench software are used for the FE analysis. The crankshaft is modeled in 3D using Pro/E software, IGES file is generated and then imported in ANSYS workbench software. The next stage was to mesh the model as shown in Figure 3.3 The 10 – node tetragonal elements (SOLID 187) were used as shown in Figure 3.4. Finite element mesh was generated using tetragonal elements with element length of 0.5 mm (2262 elements). The reason for choosing this element was to make the geometrical parts of a complicated mechanical component so enable us to gain more authentic results based on the high techniques of fatigue life calculation.

SOLID187 element is a higher order 3-D, 10-node element. SOLID187 has a quadratic displacement behavior and is well suited to modeling irregular meshes (such as those produced from various CAD/CAM systems). The element is defined by 10 nodes having three degrees of freedom at each node: translations in the nodal x, y, and z directions. The element has plasticity, hyperelasticity, creep, stress stiffening, large deflection, and large strain capabilities. It also has mixed formulation capability for simulating deformations of nearly incompressible elastoplastic materials, and fully incompressible hyperelastic materials. See *SOLID187* in the *ANSYS, Inc. Theory Reference* for more details about this element.

4. Finite element method (FEM):

Some times its become difficult to reflect the behavior of a system when it is analysed as a whole. One the other hand, it gets relatively easier to study such system, by separating it into its individual components and subcomponents. The behavior of each small component can be easily realized and incorporated to explain the behavior of entire system. This is the basic idea behind finite elements method which is as follows:

Procedure for finite element analysis

Any analysis to be perform by using finite element method can be divided into following steps :

1.Discretization
2.Choosing the solution approximation
3.Forming the element matrixes and equation
4. Assembling the matrixes.
5. Finding the unknown
6. Interpreting the results

FEM was being used by engineers for stress analysis, fluid flow analysis, heat transfer analysis etc. FEM was being used to solve complex , non linear problems, these software are being extensively used to solve complex, real life, design and analysis problems.[7]

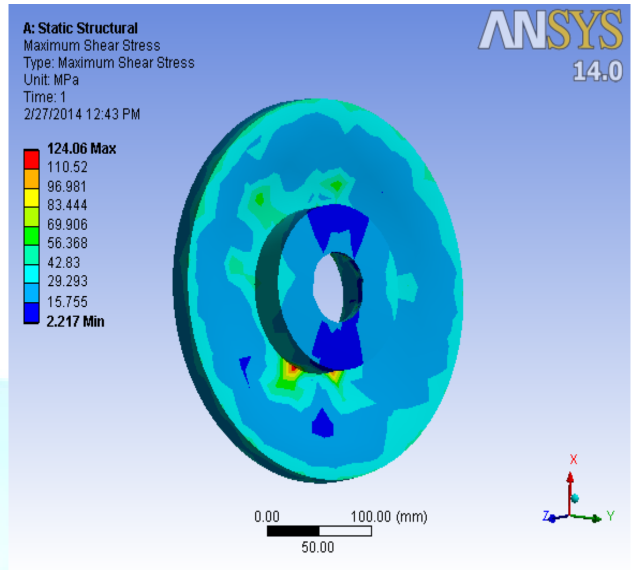

Fig.no.1 Maximum Shear Stress

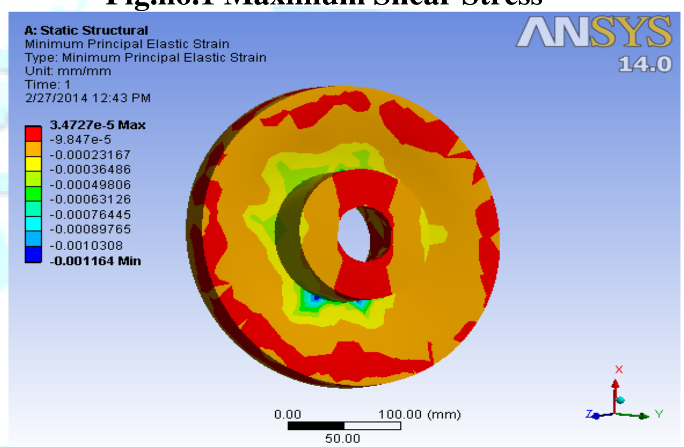

Fig.no.2 Minimum principal elastic strain

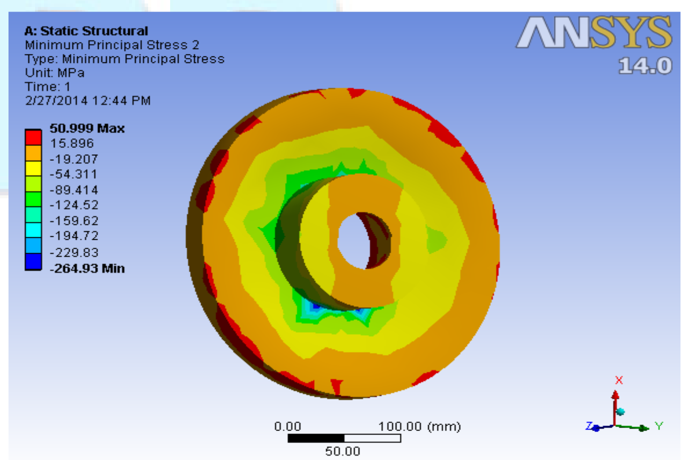

Fig.no.3 Minimum principal stress

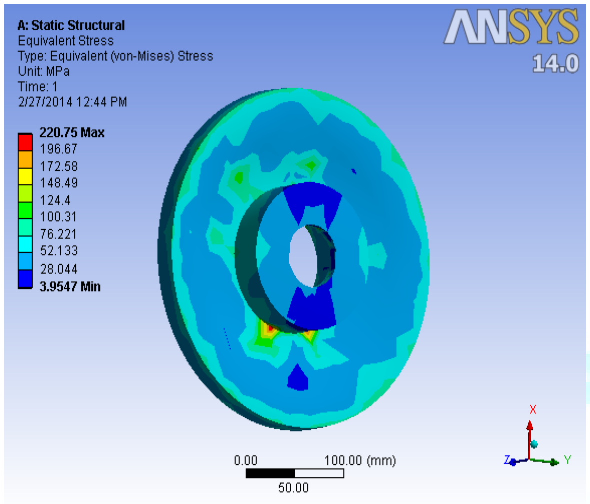

Fig.no.4 Equivalent stress

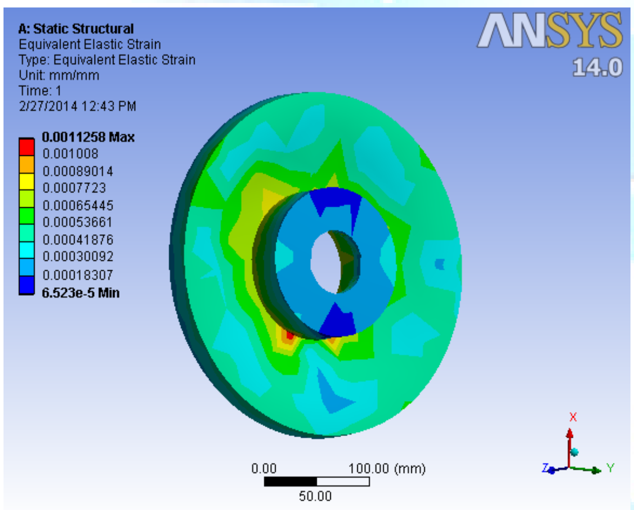

Fig.no.5 Equivalent elastic strain

5. Result and Discussions:

The investigation into utilization of new materials is needed which improve the braking efficiency and allow for larger constancy to vehicle. The suitable hybrid composite material which is lighter than structural steel and has good modulus of elasticity, Yield strength and density attributes. The low weight, the hardness, the static features also in case of high pressure and temperature of the resistance to thermal shock and the ductility provide long life time of the disk brake and keep off all troubles leading of loading, which are typical for the classic grey cast iron brake disks.

6. Conclusion

The transient thermo elastic analysis of Disc brakes in replicated brake applications has been executed. WORK BENCH software is implemented to the thermo elastic contact problem with frictional heat generation. To obtain the simulation of thermo elastic behavior appearing in Disc brakes, the coupled heat conduction and elastic equations are solved with contact problems. The effects of the friction material properties on the contact ratio of friction surfaces are examined and the larger influential properties are found to be the thermal expansion coefficient and the elastic modulus. It is observed that the orthotropic Disc brakes can provide better brake performance than the isotropic ones because of uniform and mild pressure distributions. The present study can provide a useful design tool and improve the brake performance of Disc brake system

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