Finite Element Analysis Of Disc Brake using ANSYS WORKBENCH Software

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ABSTRACT: The aim of this paper was to investigate the structural fields of the solid disc brake during short and urgent situation braking with structural material. We will take down the value of friction contact power nodal displacement and buckle for different pressure conditions using analysis software ones the value at the hand we can determine the best suitable material for the disc brake with higher life distance.Temporary structural analysis of the rotor disc of disc brake is aimed at investigation in to usage of structural gray cost iron materials is required which improve braking efficiency and provide greater stability to vehicle. We did this investigation by using WORK BENCH ANSYS 15.0 .

KEYWORDS: CREO, ANSYS WORK BENCH 15.0.

1.Introduction

The brakes must be strong enough to stop the vehicle within a minimum distance in an urgent situation. The driver must have proper control over the vehicle during urgent situation braking and vehicle must not skid. The brakes must have good antedate characteristics their effectiveness should not decrease with extended application and thus it demand that the cooling of the brakes should be very efficient. For the analysis of gray cost iron material of the disc brakes is carried out for study to structural analysis of disc brake. The disc brake is a wheel brake which slows rotary motion of the wheel by the abrasion caused by close to brake pads against a brake disc with a set of caliper. The disc brake is frequently made of brake fade. It also allows for self-cleaning as dust and water is fearful off, diluting friction difference. During the braking action, the kinetic energy developed at the wheel is translated into heat energy, which doesn't break up fast profusion into the air stream from the brake to the brake disk, as a result, the thermal conductivity plays a significant role in handling such heat generated.

2. Finite Element Analysis using ANSYS

Finite element method is a numerical method for solving any engineering problem. Because it is the mathematical representation of physical problems & it gives the approximate solution & also applicable even if physical prototype not available . ANSYS is FEA software developed by ANSYS . ANSYS involves three stages preprocessing, solution & postprocessing for solving problems. Preprocessing stage involves the preparation of FEM model, element type, real constant, material property & discretization. In Solutions stage ANSYS software automatically generates matrices that describe the behaviour of each element, assemble them & computes the unknown values primary field variables such as displacement, temperature etc.

2.1.Procedure for finite element analysis

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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

3.1 METHODOLOGY

3.1.1 Procedure of static analysis

First of all, we have prepared assembly in CREO for disc brake and save this part in IGES formate for Exporting into ANSYS WORK BENCH 15.0. Import IGES mode in ANSYS WORK BENCH simulation module then we apply material (Gray cost iron) for Disc Brake.

3.1.2 Meshing criteria

Element type solid10 node quadratic tetrahedral

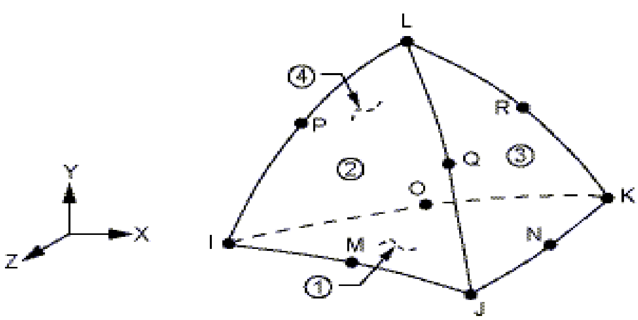

Figure 1: The 10 – node tetragonal elements (SOLID 187)

The 10 – node tetragonal elements (SOLID 187) were used for meshing purpose. Finite element mesh was generated using tetragonal elements with element length of 0.5 mm (2262 elements).

3.1.3. Meshing of the disc

The elements used for the meshing of the full and ventilated disc are tetrahedral three-dimensional elements with 10 nodes (iso parametric) (Fig.2 and 3).In this reproduction, the meshing was developed in the contact zone (disc-pad).This is important because in this zone the temperature varies considerably.

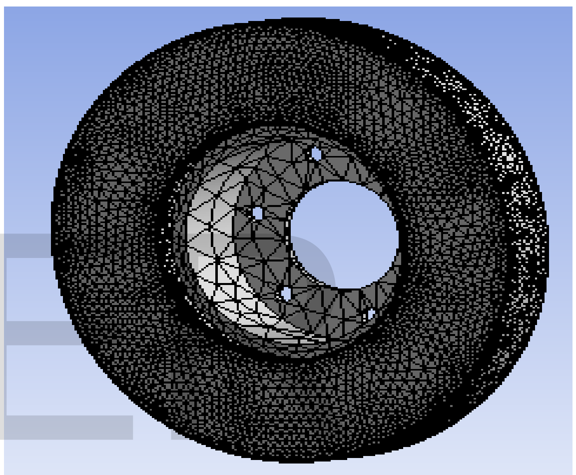

Fig.2: Meshing of a full disc in ANSYS Multiphysics (172103 nodes – 114421 elements)

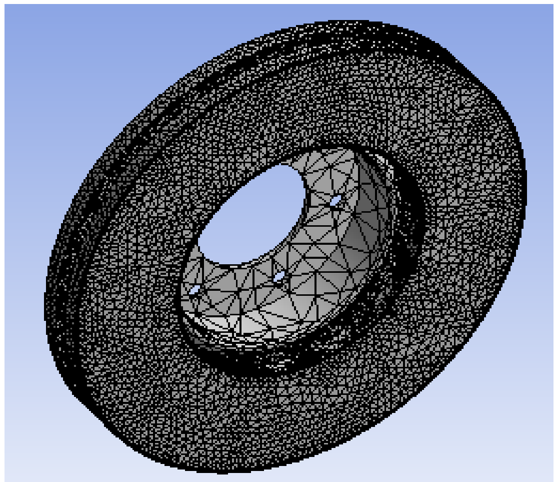

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Fig.3: Meshing of a ventilated disc in ANSYS Multiphysics (154679 nodes- 94117 elements)

Three meshes have been tested with the **convergence tool** in ANSYS WORKBENCH Multiphysics. The number of elements forming each meshing is given in Table 1.

	Full disc	Ventilated
	Number of	Number of
Mesh 1	46025	77891
Mesh 2	114421	94117
Mesh 3	256613	369777

Table 1: Number of elements of the two considered meshs

4.Material Properties for Disc Brakes

The rotor discs are commonly manufactured of grey cast iron. . It is primarily composed of Iron 95%, Carbon 2 to 5%, Silicon 1 to 3%, & also contains small percentage of Sulphur, Manganese & Phosphorus. Grey cast iron has high specific heat capacity & thermal conductivity which makes them suitable for making of rotor disc. Other properties are young's Modulus of Elasticity, Torsional Modulus of Elasticity, Crushing Strength, Brinell hardness & Endurance Limit.

4.1 The material properties of grey cast iron are:

Name	Grey Cast Iron
Model type	Linear Elastic Isotropic
Default Failure Criterion	Max von Misses Stress
Density	7100 kg/m^3
Young modulus	125 GPa
Poisson's ratio	0.25
Specific heat	586 $J/Kg.K$
Thermal conductivity	54 $W/m.K$

Table 2: material properties of grey cast iron

5.Modeling of Rotor Disc

The rotor disc modelling is done in CREO software created . It is parametric, feature-based, bi-directional associative nature solid modelling software. The assumptions which are made while modeling the process are given below. The rotor disc material is measured as homogenous and isotropic. The problem area is considered as axis- symmetric. Inertia & body force effects are negligible during the analysis.

No stress in rotor disc before the application of brake. Brakes are applied on the all 4 wheels. Rotor disc is of Solid type not ventilated. Thermal conductivity of the material used for analysis is constant. Only ambient air cooling is considered. Specific heat of rotor disc material is constant & does not change with temperature

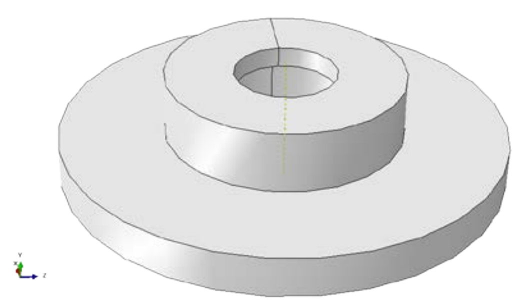

Fig.4: 3D Modeling of Rotor Disc

6.Result:

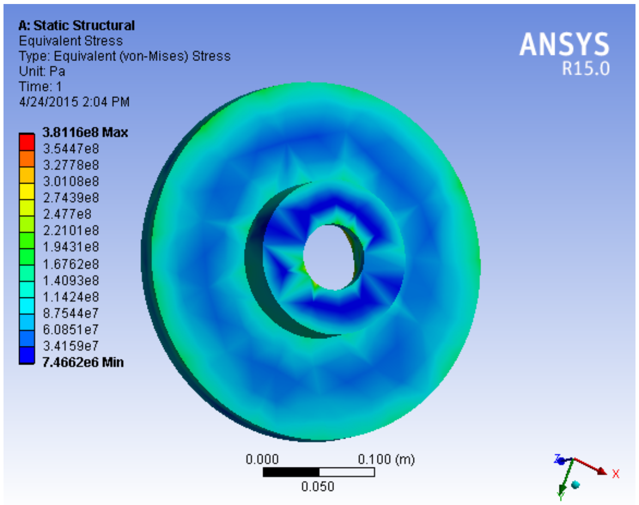

Fig.5: Equivalent stress

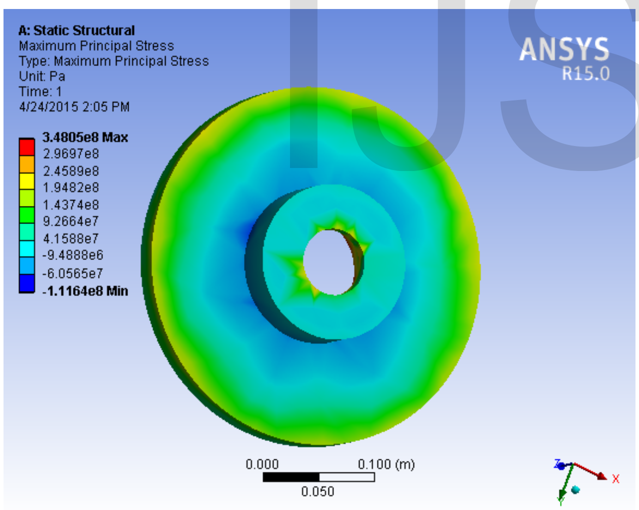

Fig.6:Maximum Principle Stress

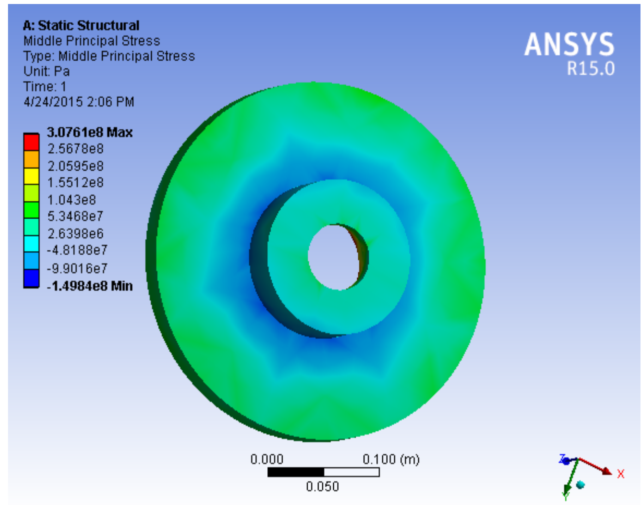

Fig.6: Middle principle Stress

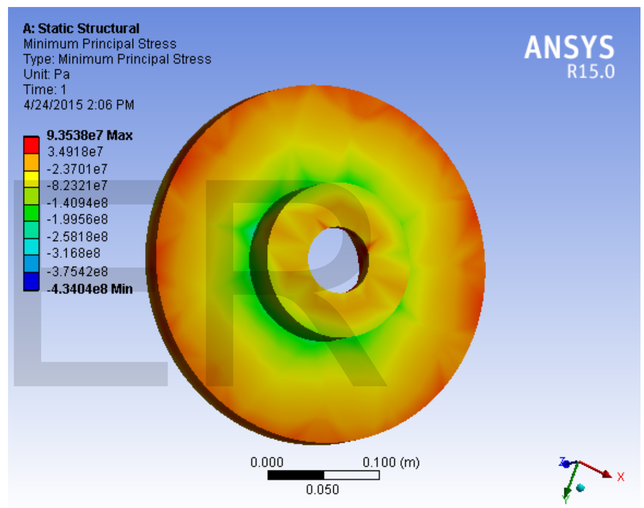

Fig.7:Minimum Principle Stress

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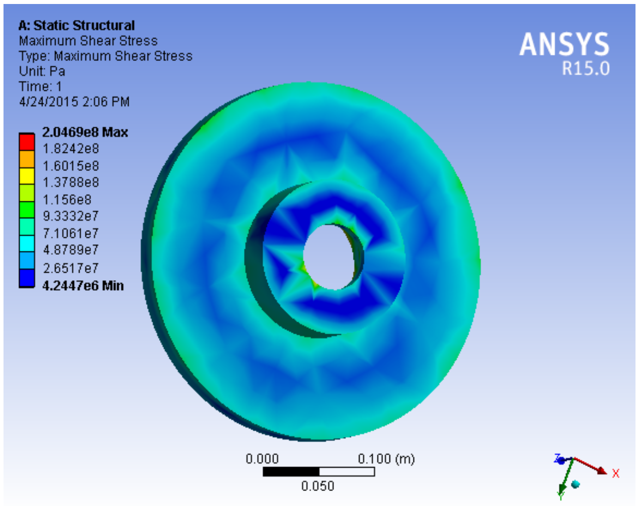

Fig.8:Minimum Share Stress

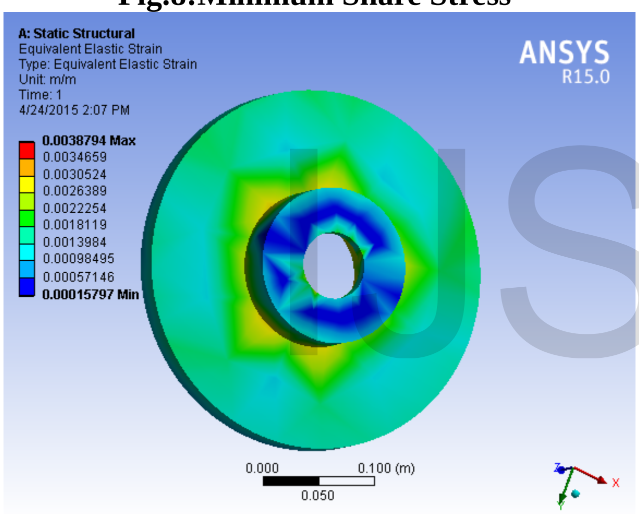

Fig.9:Equivalent Elastic Strain

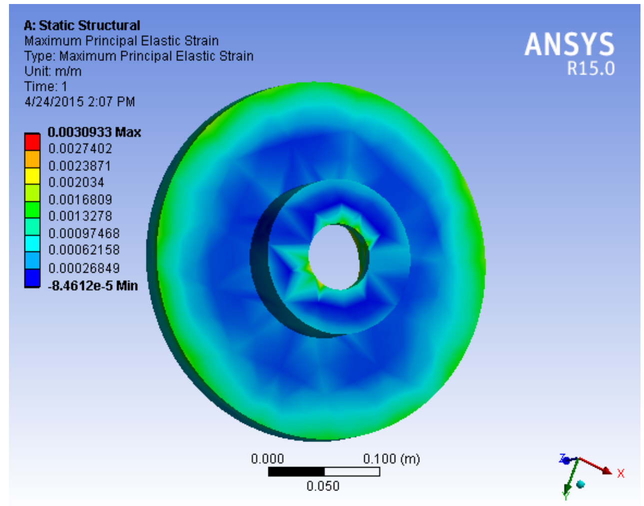

Fig.10:Maximum Principle Elastic Strain

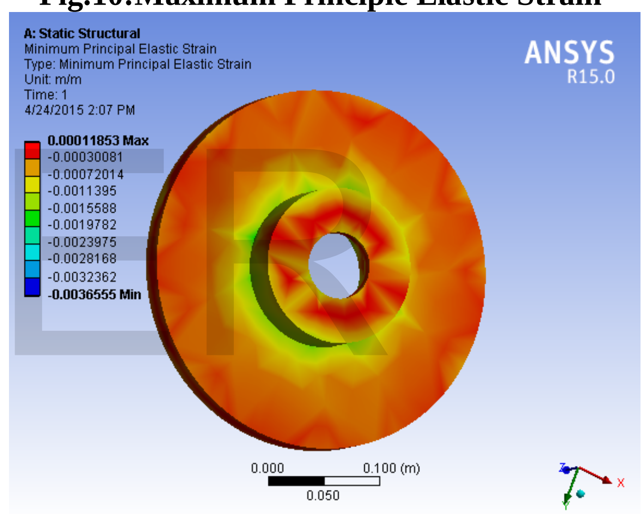

Fig.11:Minimum Principle Elastic Strain

7. Discussions:

The investigation into utilization of new materials is needed which get better the braking efficiency and allow for larger reliability to vehicle. The suitable fusion combined 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 afford long life time of the disk brake and maintain off all difficulty most important of loading, which are typical for the classic grey cast iron brake disks.

8.Conclusion

By noticing the Structural analysis results using gray cost iron stress assesses are within the permissible stress value. So using gray cost iron is good for Disc Brake. By observing the frequency analysis, the vibrations are less for gray cost iron than other materials since its natural frequency is less. And also weight of the gray cost iron reduces almost 2 times when compared with structural steel since its density is minimum. Thereby mechanical efficiency will be raised. By observing analysis results, gray cost iron are suitable material for Disc Break as compare to structural steel.

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