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Static structural analysis of ventilated disc brake upon application of fixed support, pressure, and rotational velocity

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ABSTRACT

Automotive braking systems are one of the most important safety systems of road vehicles. They are mainly used to decelerate vehicles from an initial speed to a required speed. In the current paper, static structural for the brake is done using Ansys Workbench 2019 and the CAD model is created using Solid works. This paper deals with Static Structural analysis of Ventilated Disc Brake upon application of Fixed Support, Pressure and Rotational Velocity Static Structural is much needed and monitoring that for maximum loading conditions for Ventilated Disc Brake approach can be used for prophecy purpose.

Keywords: *Ansys, Disc Brake, Workbench, Ventilated Disc Brake, Static Structural.*

1. INTRODUCTION

The circle brake is a gadget utilized for moderating or supressing the circular moment of the wheel. A brake is generally made of cast iron or ceramic composites that incorporate stainless steel, cast iron, carbon, aluminium, Kevlar, and silica which are associated with the wheel pivot to stop the vehicle. A rubbing material applied as brake pads is constrained mechanically, using pressurized water, pneumatically and electromagnetically against both sides of the plate or discs. This contact makes the circle and connected wheel back off resulting in braking. Upon harsh rubbing friction is produced resulting inti the heating of the discs and hence holes are drilled in order to cool them off and facilitate ventilation.

In this paper we are going to calculate Total deformation, Equivalent elastic strain, and Equivalent stress on the disc while fixed support, pressure and rotational velocity is applied.

2. RULES AND CONSTRAINS FOR VENTILATED BRAKES

A ventilated brake is a contact mechanical device that is used to reduce the Momentum and kinetic energy of the vehicle. A large amount of heat is generated upon breaking so the discs are padded along with cross drills to cool them faster and reduce the heat tear. Simple ventilation creates a significant optimization in the braking performance of the vehicle.

3. METHODOLOGY

The methodology goes with material selection, second cad modelling using Solid Works 2018, and thirdly analysis using Ansys Workbench 2019.

4. MATERIAL SELECTION

In **a ventilated disc** brake, the temperature generation for both grey cast iron and stainless steel is relatively small namely 73.959 °C and 169 °C. It was concluded that the **ventilated disc** brakes with grey cast iron **material** are the best for this application. In this experiment, we have used Stainless steel.

Gray Cast Iron		
QUANTITY	**VALUE**	**UNIT**
Density	7.87	g/cm3
Tensile strength Ultimate	440	MPa
Tensile Strength, yield	370	Mpa
Youngs Modulus	205	Gpa
Poisson Ratio	0.29	-

Stainless Steel		
QUANTITY	**VALUE**	**UNIT**
Density	7.85	Mg/m3
Tensile strength, Ultimate	510-620	Mpa
Tensile Strength, yield	540	Mpa
Young's Modulus	190	Gpa
Poisson Ratio	0.265	-

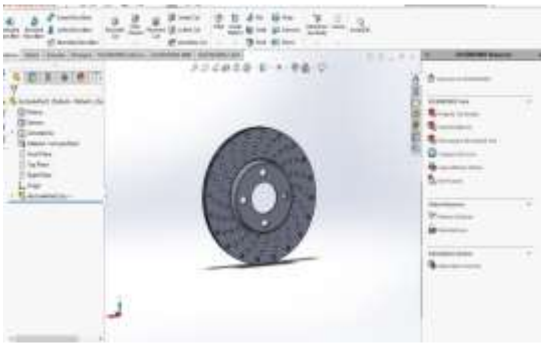
Applied Forces, Pressure and rotational speed

The brakes are mainly used against high pressures and rotational velocities. A pressure of 1 Mpa is applied along with a rotational velocity of 50 rads/sec.

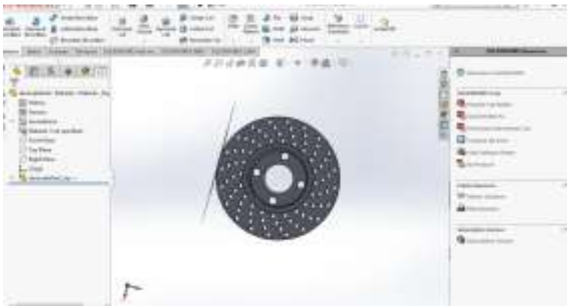
Simultaneously fixed support is applied on the inner part of the disc.

5. CAD MODEL

The Ventilated Disc Brake was designed in 3D modelling software namely Solid works 2018. The forces, pressure, and velocity above when taken into consideration, the design is made. The volume for the given part is
1.176e+006mm3. And the mass is 9.114 kg.



CAD MODEL (1)



CAD MODEL (2)

The reason for choosing Solid works as the modelling software is because its mechanical design products allow the user to create parts in a highly productive and intuitive environment, to enrich existing mechanical part design with wireframe and basic surface features. There are a lot of build in application which help the creator to design efficiently. Solid works also provides advanced drafting capabilities through the associative drawing generation from 3D part and assembly designs. Mechanical Design products can address 2D design and drawing production requirements with a stand-alone state-of-the-art 2D tool Interactive Drafting. One can create any type of 3D part, from rough 3D sketches to fully detailed industrial assemblies. The unbreakable relational design - a new way to manage links between objects and related behaviors in configured assemblies. It also enables a smooth evolution from 2D- to 3D-based design methodologies.

6. ANALYSIS

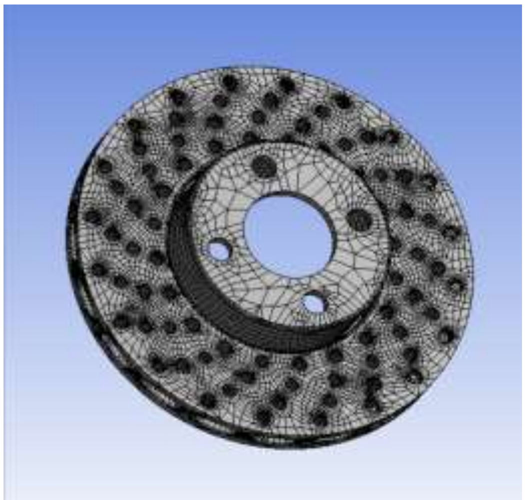
It plays a vital role in engineering design as the results of the analysis of the Ventilated Disc Brake CAD model is been carried out in ANSYS Workbench 2019. The main aim of the analysis is to find the Deformation, stress, and strain upon the action of load. Static Structural Analysis is used to determine the effect of loads on the physical bodies. Applied Mechanics, Mathematics, Material Science are used to compute the deformation, stresses, forces, reactions, and stability of the object. an object is used to verify its fitness and effectiveness for use.

The Ansys set up for the given part is done as follows:
Firstly, the geometry selection for the given part is done. Then model for the cad of the coupling is been imported and it is loaded to the system. As soon as the model is loaded, the mesh setup is done. The disc is Meshd using Firstly as a Tetrahedron method and secondly as Hex Dominant method. For the application of the force, static structural is selected and the face selection is done with required faces after that appropriate faces are chosen for the application of rotational speed and pressure. Finally, after applying total deformation, Equivalent elastic strain, and Equivalent stress the diagrams are been generated by the software in both of the meshing.

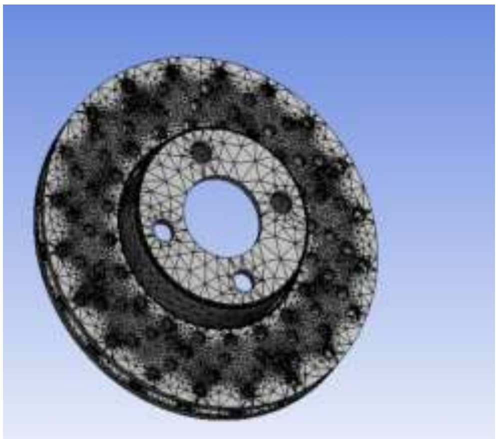
7. MESHED MODEL

The main work of meshing is to divide the part into several domains known as elements, over which the further process is been implemented. These equations approximately represent the governing equation of interest via a set of polynomial functions defined over each element. As these elements are made smaller and smaller, as the mesh is refined, the computed solution will approach the true solution. The selected element is a three-node beam element in 3-D. With default settings, six degrees of freedom occur at each node; these include translations in the x, y, and z directions and rotations about the x, y, and z directions.

Here, we have compared the use of Tetrahedral mesh along with that of Hexagonal Mesh since there are a lot of curvatures. The images for the meshed model are as below.



Hexagonal Meshing



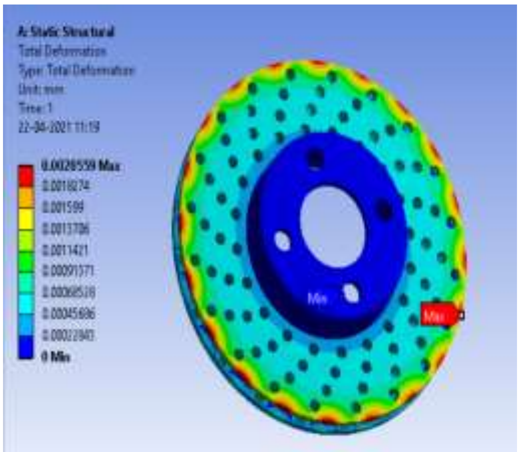
Tetrahedron Meshing

8. ANALYSIS RESULTS AND COMPARISON

After applying a pressure of 1 Mpa is applied along with a rotational velocity of 50 rads/sec and fixed support on the inner part of the disc, Total deformation, Equivalent elastic strain, and Equivalent stress the diagrams are been generated by the software in both of the meshing.

Also, the Maximum and Minimum results Corresponding to each are generated.

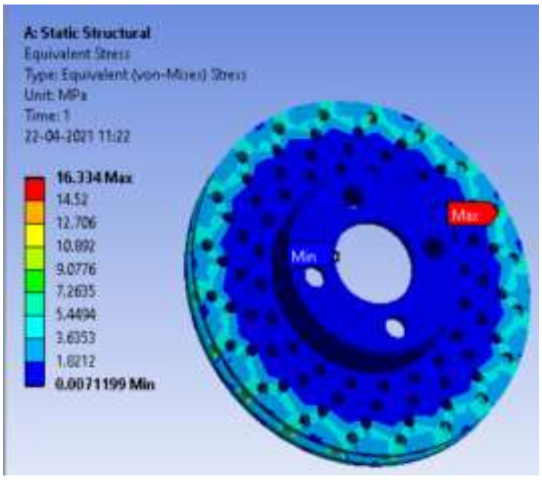
9. FOR TETRAHEDRON



Total Deformation for Tetrahedral Mesh

Results	
Minimum	5.1718e-008 mm/mm
Maximum	8.5455e-005 mm/mm
Average	1.1268e-005 mm/mm
Minimum Occurs On	discbrakePart2-Fre...
Maximum Occurs On	discbrakePart2-Fre...

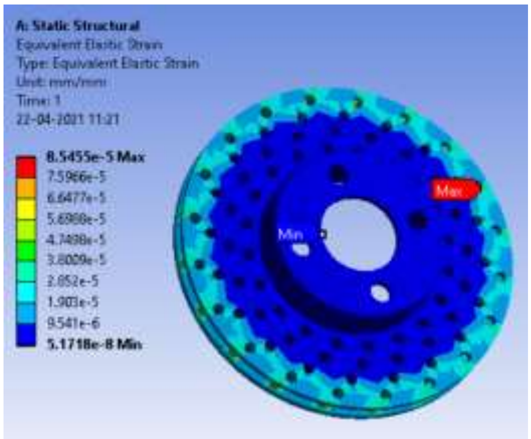
Equivalent elastic strain results for Tetrahedral Mesh



Total Deformation results for Tetrahedral Mesh

Results	
Minimum	0. mm
Maximum	2.0559e-003 mm
Average	4.8623e-004 mm
Minimum Occurs On	discbrakePart2-Fre...
Maximum Occurs On	discbrakePart2-Fre...

Equivalent stress for Tetrahedral Mesh

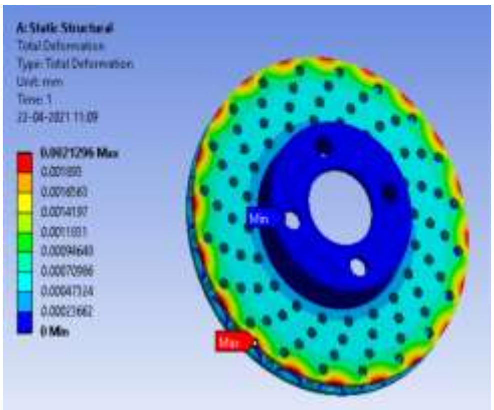


Equivalent elastic strain for Tetrahedral Mesh

Results	
Minimum	7.1199e-003 MPa
Maximum	16.334 MPa
Average	2.0631 MPa
Minimum Occurs On	discbrakePart2-Fre...
Maximum Occurs On	discbrakePart2-Fre...

Equivalent stress results for Tetrahedral Mesh

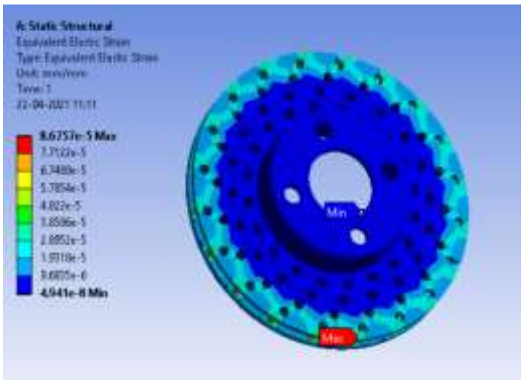
10. FOR HEXAGONAL



Total Deformation for Hexagonal Mesh

Results	
Minimum	0. mm
Maximum	2.1296e-003 mm
Average	5.6042e-004 mm
Minimum Occurs On	discbrakePart2-Fre...
Maximum Occurs On	discbrakePart2-Fre...

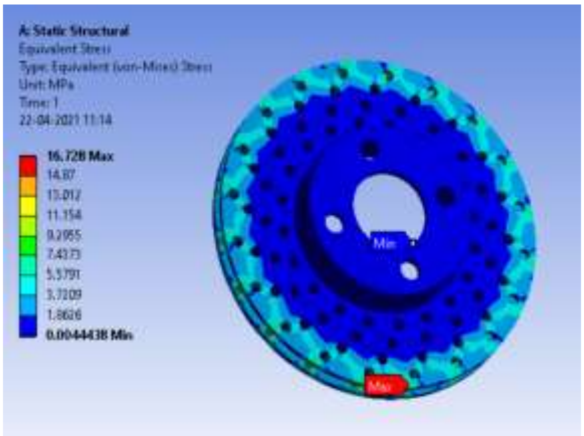
Total Deformation results for Hexagonal Mesh



Equivalent elastic strain for Hexagonal Mesh

Results	
Minimum	4.941e-008 mm/mm
Maximum	8.6757e-005 mm/mm
Average	1.2645e-005 mm/mm
Minimum Occurs On	discbrakePart2-Fre...
Maximum Occurs On	discbrakePart2-Fre...

Equivalent elastic strain results for Hexagonal Mesh



Equivalent stress for Hexagonal Mesh

Results	
Minimum	4.4438e-003 MPa
Maximum	16.728 MPa
Average	2.3576 MPa
Minimum Occurs On	discbrakePart2-Fre...
Maximum Occurs On	discbrakePart2-Fre...

Equivalent stress results for Hexagonal Mesh

11. CONCLUSION

In this paper, structural analysis of the Ventilated Disc brake is completed where Total deformation, Equivalent elastic strain, and Equivalent stress are taken into consideration. Upon applying a pressure of 1 Mpa, a rotational velocity of 50 rads/sec, and fixed support on the inner part of the disc, both the Mesh Structures (Tetrahedral and Hexagonal) deform. However maximum deformation is observed in Hexagonally meshed structure and hence is preferred for usability.

12. REFERENCES

[1] International Journal of Mechanical Engineering and Technology (IJMET) Volume 9, Issue 3, March 2018, pp. 846-856 Article ID: UMET_09_03_086 Available online at http://www.iaeme.com/IJMET/issues.asp?T ype=UMET&VType=9&IType=3 ISSN Print: 0976-6340 and ISSN Online: 0976-6359 "STRUCTURAL ANALYSIS OF DISC BRAKE" M.D. Rajkamal Assistant Professor, Department of Mechanical Engineering, Velammal Institute of Technology, Chennai601204,

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