IJESRT: 10(3), March, 2021 ISSN: 2277-9655

International Journal of Engineering Sciences & Research Technology

(A Peer Reviewed Online Journal)
Impact Factor: 5.164

IJESRT

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

IJESRT
INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

TRANSIENT THERMAL ANALYSIS OF DOUBLE DISK BRAKE ROTOR OF DIFFERENT MATERIALS USING HYBRID MECHANISM

PG scholar Student, Krishnapal Singh[*1] & Assistant Professor, Nitin Jaiswal[2]
[1&2]Department of Mechanical Engineering, Lakshmi Narayan Collage of Technology and Science Indore

DOI: https://doi.org/10.29121/ijesrt.v10.i3.2021.4

ABSTRACT
This paper is presented on Design and Thermal analysis of disc brake rotor of different materials, which analyze about on disc brake rotor by analysis of different shapes of slot of different vehicles Disc brake rotor. Therefore, it can optimize number of shapes of slot to estimate the good thermal conductivity of the disc brake rotor. CATIA V5R21 and ANSYS 19R1 software's are using for Modeling, Static and Transient Thermal Analysis. Heat generated is dissipated faster or the disc material gets less heated. Here is consideration of a metal multiple materials which will satisfy above criteria. An analysis of composite and SS disc brakes over a repeated braking is done and the results are analyzed.

KEYWORD: Brake, Thermal analysis, Disc Rotor, CATIA V5R21, ANSYS 19R1.

1. INTRODUCTION
The braking system provides the means to stop a car. The braking system is considered by many people to be the most important system involved in the operation of a vehicle. The ideal braking systems is one that will allow the driver to bring a vehicle to a stop in the shortest possible distance.**Abbas et al.** highlighted the distortion effect of coning and using a computer program, produced a method of calculating stresses in a solid brake disc from an initial known temperature distribution [11]. **Abbas,** followed relating experimental work to confirm the previous theoretical research, using a static test rig to heat the disc and then allow it to cool, whilst thermocouples and strain gauges recorded the data. Good agreement was found [12]. **El-Sherbiny and Newcomb** derived a numerical method Numerical methods were now being used because the increased complexity of problems and original assumptions that had now been found to be unacceptable could not be contained within a purely analytical solution [13]. **Joining Ashworth et al.** proceeded to apply methods to brake drums. Distortion was able to be modeled for a variety of contact cases and modifications to the drum made for improved cooling and therefore thermal distortion [14]. **Sisson** uses Duhamel's theorem to combine the advantages of the precision of an analytical solution with the approximate solutions of a more geometrically precise model obtained with numerical methods [15]. **Harding and Newcomb** produced a comprehensive modelling system using the PAFE C finite element software package in 1979[16]. **Newcomb** returned with further work achieved using an extension of the computer scheme outlined in the paper above. -22 - In this exposition frictional heat generated during braking and wear on the components were included in the analysis, whereas before only the mechanical forces and displacements had been examined [17].

2. RESEARCH AND METHODOLOGY
The methodology flow of research is shown in figure:1 first of all we have to select a Suitable material for disc rotor after that cad model will be prepared in CATIA V5 and then will perform transient thermal analysis of different material and different type of disc rotor and then compare with base result.

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

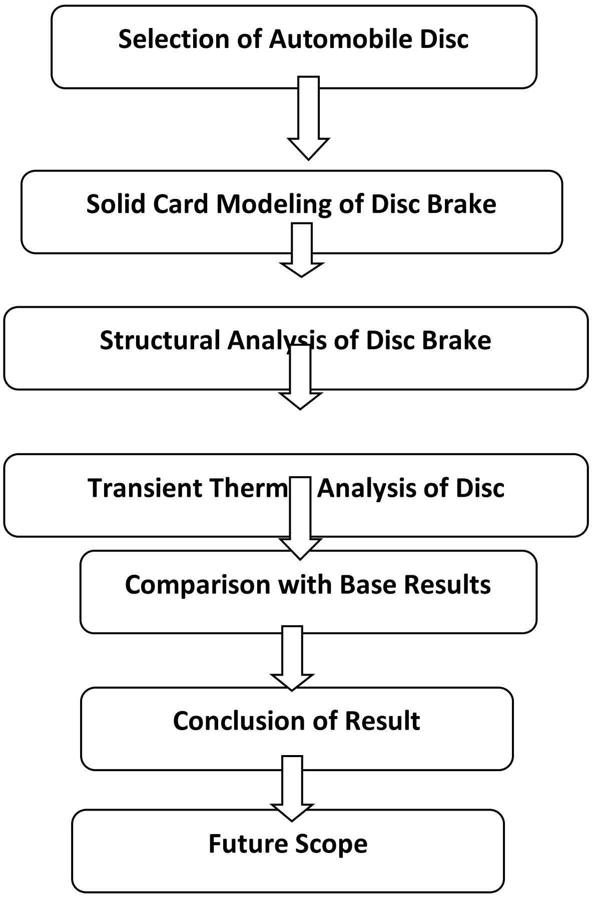

Figure: 1 Flow Chart of Methodology

As above mentioned figure it shows that steps for research work about solid card and its structure of disc brake. Transient thermal analysis of disc is shows in step four after that it will move to conclusion and future work.

3. DISC AND CALIPER/PAD DESIGN

Although much of this work has yet to be put into practice it is hoped that the reasons for and the mechanisms of brake disc thermal distortion have been demonstrated with clarity. Disc design will never be a rigidly defined procedure, the judgment and experience of the designer are naturally crucial but it is necessary to found judgments on sound bases and it is to this end that this thesis has been prepared. It is important to design the disc for the uses to which is will be put and it is hoped that adequate demonstration has been made of the possibility for producing a design with quite particular performance in mind. Many variables are there to be changed and if some understanding is obtained of the effect of each then a disc can be designed with very specific aims in mind and with as little mass as possible.

It was not originally within the brief of this project to examine these components but the results of the necessary modelling of the pads are important and need discussing. As has been said many times previously, the pad pressure distribution is important to achieving stable braking conditions. There is little point in designing a disc with great accuracy if the loads placed upon it are detrimental to its operation. In the case of the pads examined here, there is a vast difference between the two, caused by necessary caliper design and a combination of high friction pad material compressibility and chosen pad back plate thickness. Pad #1 in particular is very bad, the pressure concentration occurring at the outer edge of the disc.

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

4. COMPARATIVE RESULTS

Cast iron is a group of iron-carbon alloys with a carbon content greater than 2%.[1] Its usefulness derives from its relatively low melting temperature. Below diagram represents the Results.

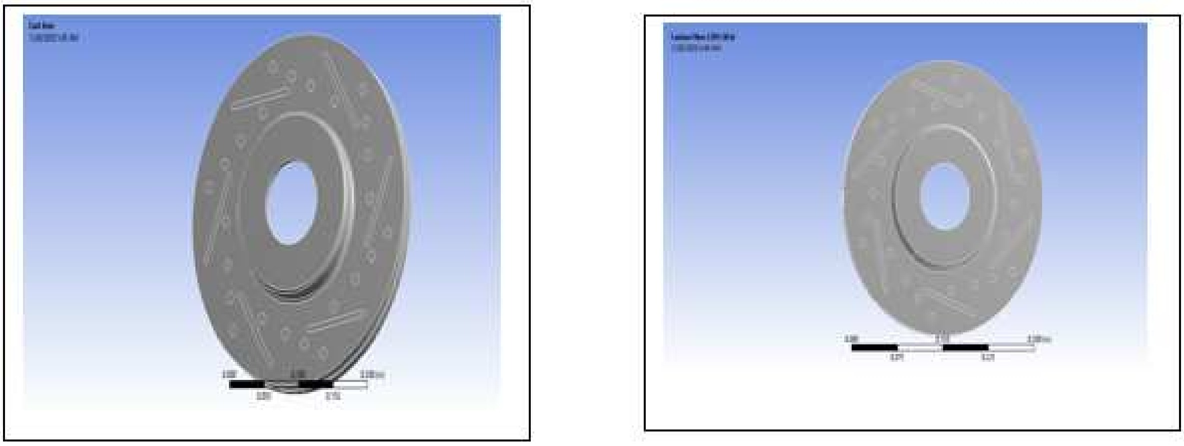

Figure: 2 Results of Cast iron and Carbon fiber Disk Brake

Carbon carbon or carbon fiber:-Carbon fiber reinforced carbon, carbon–carbon, or reinforced carbon–carbon (RCC) is a composite material consisting of carbon fiber reinforcement in a matrix of graphite.

Ceramic matrix composites (**CMCs**) are a subgroup of composite materials as well as a subgroup of ceramics. They consist of ceramic fibers embedded in a ceramic matrix.

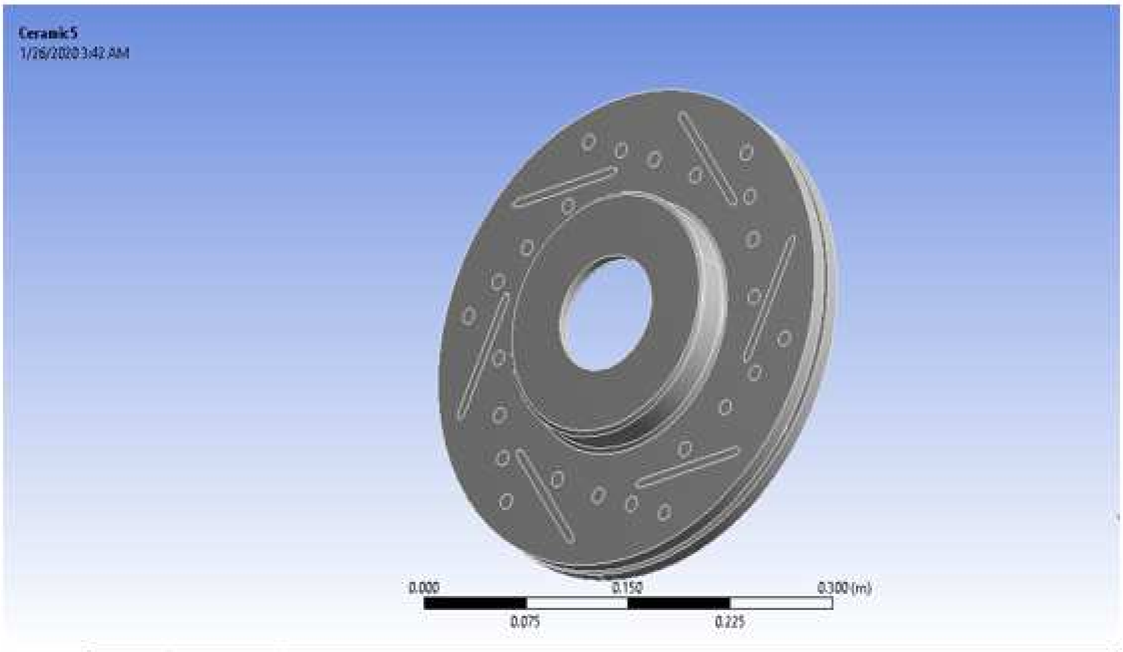

Figure: 3 Results of Ceramic matrix Composite

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

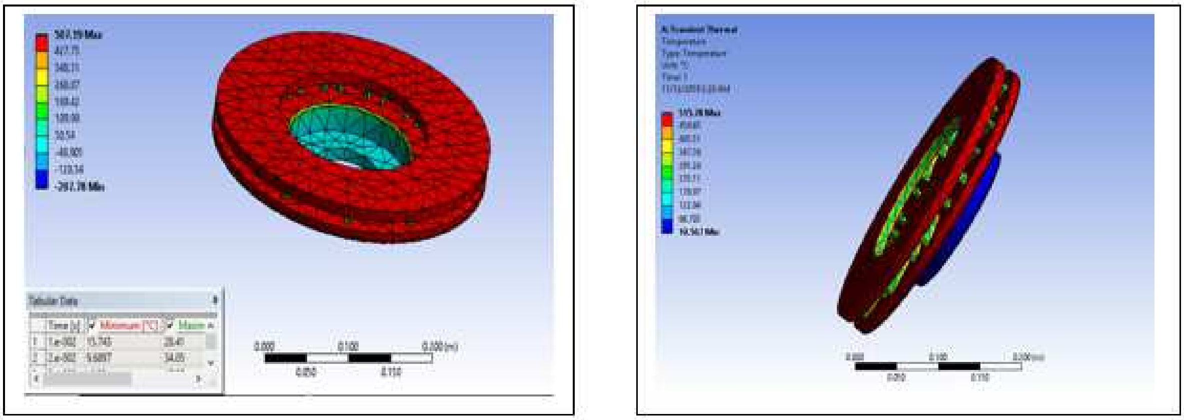

Figure: [4, 5] Results of Temperature distribution for Carbon fiber and Ceramic matrix

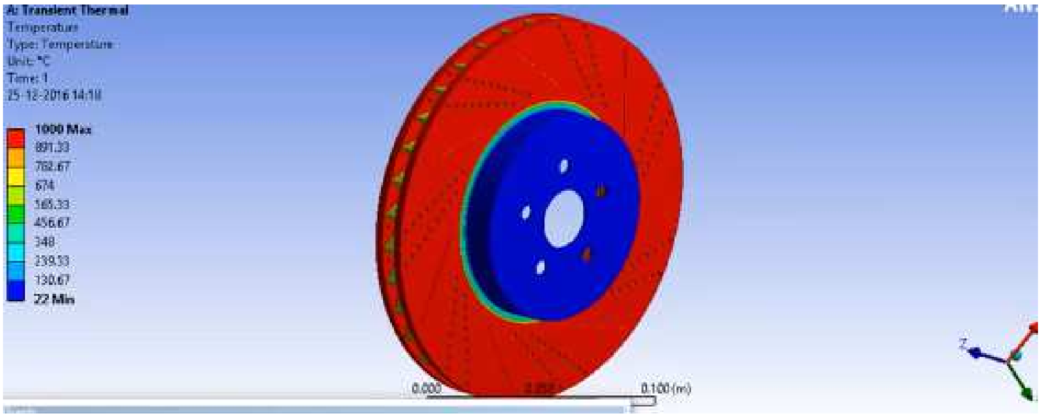

Figure: 6 Maximum Temperature distribution

TABLE: 1 Transient state temperature distributions for different materials

TIME IN SECONDS	CAST IRON TEMP	STEEL TEMP	AI-MMC TEMP
1	314.91	319.6	302.45
2	295.65	296.63	300.74
3	298.17	298.17	300.85
4	300.83	300.83	300.01

In table: 1 showing results as per existing work which was done by different authors and researchers and then it will try to work on other materials.

TABLE: 2 Transient state temperature distributions for different materials

Time in seconds	Cast iron temp	Carbon Fiber	Ceramic matrix Composite
1	188.62	280.64	268.1
2	238.65	296.52	288.74
3	288.5	300.554	298.58
4	338.18	300.558	301.03

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

Boundary condition

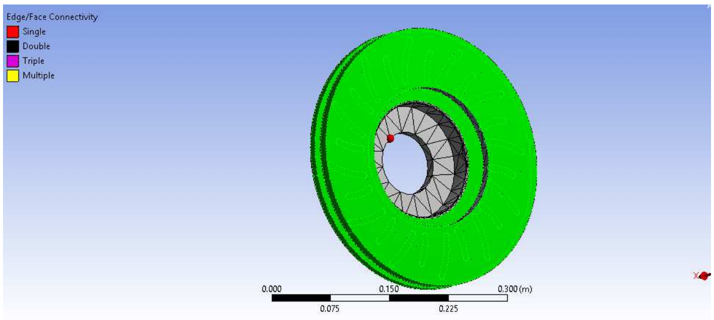

Figure : 7 Inlet Boundry condition

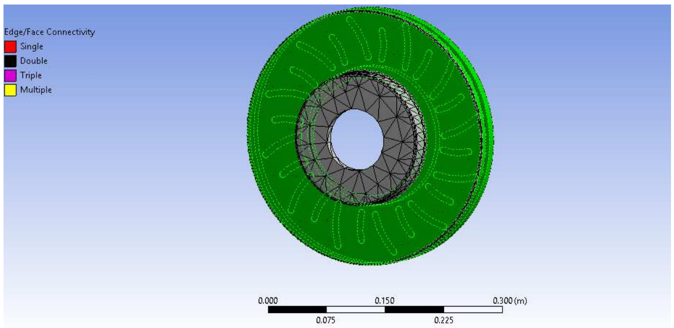

Figure : 8 Outlet boundry condition

5. TRANSIENT THERMAL ANALYSIS

A transient thermal analysis calculates temperatures and fluxes in your model over a particular time range. It can direct ANSYS Simulate to report full results or temperature loads at specified time intervals. In thermal FEA models, choices of elements size shape and order, as well as high Biot number convective loads, can sometimes result in non-physical temperature results such as temperatures that are higher or lower than any applied temperature. In transient models, the use of small time sub steps can amplify the effect with high-order elements.

6. RESULT AND ANALYSIS

The meshing is based on the concept of discretization of domain which means converting solid models to finite element models that is converting it into nodes and elements of appropriate mesh density and size. If mesh density is too fine it will take high computational time and mesh density is too low would result in compromise of accuracy level of solution. Heat flux boundary conditions are applied with value of 385.67 W/m2 and convection value of 7.9W/m2 for cast iron to air, 11.3W/m2 from steel to air, 90 W/m2 from Al-MMC to air. Ambient temperature is set to 280C. For CFD simulation the same model is imported in ANSYS CFX. Enclosure surrounding CAD model is generated with dimensions of .1m*.1m*.1m. Boolean operation is done where disc brake volume is subtracted from enclosure volume. The fluid domain type is taken for analysis with inlet boundary of air at 2.5 m/sec for low speed and 10 m/sec for high speed is taken. The turbulence model taken is k-epsilon which is easier to simulate and can handle complex models. The outlet boundary condition is set to zero relative pressure condition. The energy model taken for analysis is thermal energy which takes into account of change in temperature. Convergence criteria set for analysis is RMS residuals to 1e-4.

REFERENCES

[1] KENNEDY, F. E., COLIN, F. FLOQUET, A. AND GLOVSKY, R. Improved Techniques for Finite Element Analysis of Sliding Surface Temperatures. Westbury House page 138-150, (1984).
[2] A. R. Abu Bakar and H. Ouyang, Wear prediction of friction material and brake squeal using the finite element method. Wear, Vol.264 No.11-12, pp.1069-1076,2008.
[3] Muhamad Ibrahim Mahmod, Kannan M. Munisamy, ―Experimental analysis of ventilated brake disc

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

with different blade configuration‖ Department of mechanical Engineering, Vol. 1, PP 1-9, 2011

[4] P.F.Gotowicki, V.Nigrelli and G.V.Mariotti, Numerical and experimental analysis of a pegs-wing ventilated disk brake rotor, with pads and cylinders, In: 10th EAEC Eur.Automot. Cong – Paper EAEC05YUAS04– P 5, June, 2005.

[5] Hudson, M., Ruhl, R., Ventilated brake rotor air flow investigation, SAE Technical Paper 971033, 1997.

[6] Wallis, L., Leonardi, E., Milton, B., Air flow and heat transfer in ventilated disc brake rotors with diamond and tear-drop pillars, Proceedings of International Symposium on Advances in Computational Heat Transfer, Australia, 2002, pp. 643–655.

[7] Lee, K. J., Barber, J. R., An experimental investigation of frictionally-excited thermo elastic instability in automotive disk brakes under a drag brake application, Journal of Tribology 116 (1994) 409–414.

[8] Lee, K., Barber, J. R., Frictionally excited thermoelastic instability in automotive disk brakes, ASME Journal of Tribology 115 (1993) 607–614.

[9] Vold˘rich, J., Frictionally excited thermo elastic instability in disc brakes-transient problem in the full contact regime, International Journal of Mechanical Sciences 49 (2007) 129–137.

[10] Zagrodzki, P., Thermo elastic instability in friction clutches and brakes-transient modal analysis revealing mechanisms of excitation of unstable modes, International Journal of Solids and Structures 46 (2009) 2 463–2 476.

[11] Department of Intelligent Mechanical System Engineering, Kochi University of Technology, Miyanokuchi, Tosayamada-cho, Kochi 782-8502, Japan. E-mail: sakamoto.haruo@kochi-tech.ac.jp

[12] Haly Abbas (949–982 AD) Arman Zargaran • Mohammad M. Zarshenas • Seyedeh Aida Ahmadi • Karim Vessal in December 2012

[13] Thermal behavior of friction clutch disc based on uniform pressure and uniform wear assumptions Oday I. ABDULLAH1,2,*, Josef SCHLATTMANN1 1 System Technologies and Mechanical Design Methodology, Hamburg University of Technology, Hamburg 21073, Germany 2 Department of Energy Engineering, College of Engineering, University of Baghdad, Baghdad-Aljadria 47024, Iraq Received: 11 May 2016 / Revised: 22 June 2016 / Accepted: 04 July 2016 © The author(s) 2016. This article is published with open access at Springerlink.com

[14] Abu Bakar, A. R., Ouyang, H., Wear prediction of friction material and brake squeal using the finite element method, Wear 264 (11–12) (2008) 1 069–1 076.

[15] Abdo, J., Experimental technique to study tangential to normal contact load ratio, Tribology Transactions 48 (2005) 389–403.

[16] P. R. J. Harding Flexural Effects in Disc Brake Pads.
P. R. J. Harding Manager Engineering Research, Mintex Ltd., Cleckheaton, Yorkshire First Published June 1, 1978

[17] T.P. Newcomb D.Sc., N. Millner, B.Sc. Cooling Rates of Brake Drums and Discs First Published January 1, 1965 Research Article https://doi.org/10.1243/PIME_AUTO_1965_180_019_02.