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#### “REVIEW PAPER ON DESIGN & THERMAL ANALYSIS OF CAR BRAKE ROTOR”

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#### ABSTRACT

*This paper reviews numerical methods and analysis procedures used in the study of automotive disc brake. It covers Finite element Method approaches in the automotive industry, the complex Contact analysis. The advantages and limitations of each approach will examine. This review can help analysts to choose right methods and make decisions on new areas of method development. It points out some outstanding issues in modeling and analysis of disc brake squeal and proposes new conceptual design of the disk braking system. It is found that the complex Contact analysis is still the approach favored by the automotive industry. Analysis of brake rotor includes Structural analysis and Steady state Thermal analysis for each design..This paper reviews work of previous investigators on Structure and transient analysis on the vented disk rotor and rotor designs to evaluate and compare their performance.*

**Keyword:** Structure Analysis, Disc, FEM, Braking System, Automotive Industry

#### I. INTRODUCTION

The disc brake is of two type solid full and ventilated. The disc brake is a device for slowing or stopping the rotation of a wheel. A brake disc (or rotor) usually made of cast iron or ceramic composites (including carbon, Kevlar and silica), is connected to the wheel and/or the axle. To stop the wheel, friction 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. These brakes offer better stopping performance than comparable drum brakes, including resistance to "brake fade" caused by the overheating of brake components, and are able to recover quickly from immersion (wet brakes are less effective). Discs have now become the more common form in most passenger vehicles, although many (particularly light weight vehicles) use drum brakes on the rear wheels to keep costs and weight down as well as to simplify the provisions for a parking brake. As the front brakes perform most of the braking effort, this can be a reasonable Compromise.

Friction brakes act by generating frictional forces as two or more surfaces rub against another. 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.



**Figure.1 Car Rotor disc**

We introduced variation in vanes pattern on the disc in ventilated disc brake. The Heat transfer rate is increase. Time taken for cooling the disc is high. It has been seen that the generation of huge amount of temperature on disc surface during braking needed to be dissipated as efficiently and soon as possible.

It's observed that many factors are responsible which restricts heat dissipation, ultimately leading to brake failure due to situation like brake fade and judder. Factors such as Vehicle speed, type of braking (Emergency braking or repetitive braking), rotor geometry and dimension, disc or pad materials (Cast iron, Aluminium metal matrix composite, ceramics etc), contact pressure distribution etc are some certain factors which can be varied to achieve a satisfactory heat dispersion.

## II. LITERATURE REVIEW

**Pravin Mohan and Patel Sudheendra S [ 2017]** The after work contemplates an applied plan of a circle brake system. Circle brakes offer higher execution braking, easier structure, lighter weight, and preferable protection from water obstruction over drum brakes. The point of this calculated structure was to build the quality of the caliper, without expanding the heaviness of the caliper by an extensive sum and decreasing the warm disfigurement at high working temperatures. Since titanium is hard to machine the mono square structure of traditional machined caliper was not utilized in this work but rather an endeavor was made to fabricate a brake caliper with various parts and gathered together to make a solitary unit. Likewise titanium parts utilized were machined from plates with no convoluted shapes to save money on machining costs in future. Since titanium has higher mass thickness care was taken while structuring the new brake system to keep the load increment to least. The current brake caliper was broke down for given load conditions with new material proposed. The outcomes were considered for relocations and worries alongside warm impacts. The new particular caliper was broke down for weight and digressive load sand the outcomes were considered for relocations/disfigurement and worries with temperature impacts. [1]

**S. Arvin Rao, MuhamadAnuwarJusoh, Abd Rahim Abu Bakar\*,(2017)** Brakes screech has stayed to be one of the real Noise, Vibration and Harshness (NSH) challenges in brake system structure and improvement. It has been a worry for automotive industry for decade. Brake specialists have proposed many brake screech decrease and aversion techniques so as to survive and diminish the screech that radiates from the brake plate systems. In this paper, the adequacy of compelled layer dampers (CLD) in decreasing plate brake screech commotion was explored. CLD secludes the brake screech commotion through shear distortions of the viscoelastic materials. Two arrangements of brake tests were directed utilizing the brake test dynamometer with the use of CLD. Two distinct kinds of CLD were utilized which are three-layer obliged layer damper and four-layer compelled layer damper. Screech tests were carried out utilizing brake clamor test fix dependent on the worldwide standard strategy SAE J2521. From the test, four-layer CLD design works more proficient than three-layer CLD arrangement. CLD made up of nitrile butadiene elastic, silicone elastic and mellow steel turned out to be the best commotion encasing at water powered weight scope of 5 bar

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to 30 bar and temperature scope of 50oC to 200oC with a most extreme clamor decrease of 11.3 dBA. Subsequently, CLD procedure was ended up being a powerful technique in diminishing brake screech noise.[2]

**Yugesh Anil Kharche and Prof. Dheeraj Verma [2014]** The circle brake is a gadget for decelerating or halting the revolution of a wheel. Braking is a procedure which changes over the motor vitality of the vehicle into mechanical vitality which must be scattered as heat. This paper introduces the investigation of the contact weight disseminations at the plate interfaces utilizing a point by point 3-dimensional limited component model of a genuine car circle brake. Limited component (FE) models of the brake-circle are made utilizing Pro-E and reenacted utilizing ANSYS which depends on the limited component technique (FEM). It is likewise researches distinctive dimensions in displaying a plate brake system and mimicking contact weight disseminations at different load. It covers Finite Element Method approaches in the automotive business the Contact examination and warm investigation. The impact of the rakish speed and the contact weight appropriation on temperature ascent of plate brake was examined. Wear in rubbing material implies that decrease of its life expectancy. The more the wear, the sooner the frictional material should be supplanted. Diverse Brake cushion material is tried as contrasted and the current one. At long last correlation between diagnostic outcomes and result got from Ansys carried out, and every one of the qualities got from the examination are not exactly their admissible qualities. Thus based on warm and contact pressure investigation best appropriate material is suggested.[3]

**K. M. Muniswamy et al. (2013)**, heat exchange improvement on ventilated brake plate with edge tendency edge variety. The goal of the present examination is to research the potential heat move upgrades in ventilated brake plate by shifting the geometrical parameters of the edges inside the stream entry. The thickness stays steady and just the length can be changed to fit the inward and external span. The computational model built in GAMBIT. The models are fathomed utilizing ANSYS-FLUENT exclusive programming bundle. The outcomes demonstrate a huge increment in the heat exchange rate with edge tendency edge arrangements when contrasted with customary straight sharp edge. The Nusselt number is observed to be in a power-law association with the Reynolds number. Particular connection among laminar and tempestuous condition is anticipated. [4]

**K. Sowjanya&S.Suresh (2013)**, exhibited paper on Structural examination of circle brake rotor. Circle brake is normally made of Cast press, so it is being chosen for examining the impact of solidarity minor departure from the anticipated pressure circulations. Aluminum Metal Matrix Composite materials are chosen and investigated. The space is considered as hub symmetric, latency and body drive impacts are irrelevant amid the investigation. The model of Disk brake is created by utilizing Solid demonstrating programming Pro/E (Cero-Parametric 1.0).Further Static Analysis is finished by utilizing ANSYS Workbench. Warm answer for the auxiliary investigation and the most extreme Von Misses pressure was seen to be 50.334 M Pa for CI, 211.98 M Pa for AlMMC1, and 566.7 M Pa for AlMMC2, the Brake plate configuration is protected dependent on the Strength and Rigidity Criteria[5]

**Zhang Jiang& Xia Changgao (2012)**, research of the transient temperature field and erosion properties on circle brakes. The 3D transient and cyclic symmetry limited component model of the temperature field of the ventilation caliper plate brake in a long downhill braking condition was built up in this paper. The limited component demonstrating for three-dimensional transient cyclic symmetry amid the long downhill braking is set up. The variety of the grating element joined with the temperature qualities of the grinding factor amid the braking are investigated. Examination is finished by utilizing limited component programming ANSYS. Amid the braking, the temperature of the brake rises progressively and achieves the best temperature of 316.04°C toward the finish of braking process; the high temperature segment moves in the most distant zone of the rubbing surface. The greatest rate of subsidence is 8.16%, rubbing coefficient is constantly steady inside a sensible range, and the undeniable warm retreat isn't happened.[6]

**Piotr Grzes and Adam Adamowicz (2011)**, introduced paper on examination of circle brake temperature appropriation amid single braking under non-axisymmetric stack . Initial step of the investigation dependent on the recently created model where the force of heat motion was thought to be consistently conveyed on the rubbing surface of plate amid braking process, and the heat is moved solely pivotal way, while amid the second, the three dimensional

rotor is exposed to the non-hatchet symmetric warm load to reproduce reasonable warm conduct of the brake activity. Task conditions, thermo-physical properties of materials and measurements of the brake system were received from the genuine portrayal of the braking procedure of the traveler vehicle. Discretionarily chosen four estimations of the speeds right now of brake commitment were connected to the models in order to examine their effect on the got arrangements of the temperature advancements on the contact surface of the circle volume alluding to two isolated limited component examination. [7]

**JIANG LAN et al. (2011)**, presented paper on warm examination for brake plate of Sci/6061 Al. Compound co-constant composite for CRH3 amid crisis braking considering wind current

Cooling. The warm and push examinations of SiCn/Al brake circle amid crisis braking at a speed of 300 km/h considering wind stream cooling were examined utilizing limited component (FE) and computational liquid elements (CFD) techniques. Each of the three methods of heat exchange were investigated. The most elevated temperature after crisis braking was 461 °C and 359 °C without and with considering wind stream cooling, individually. The proportionate pressure could achieve 269 MPa and 164 MPa without and with considering wind current cooling, separately. The wind current through and around the brake circle was broke down utilizing the Solidwork2012 reproduction programming bundle. The outcomes recommended that the higher convection coefficients accomplished with wind stream cooling won't just diminish the greatest temperature in the braking yet in addition lessen the warm angles, since heat will be expelled quicker from more smoking parts of the disk[8]

**Oder G. et al. (2009)**, worked on warm and stretch investigation of brake circles in railroad vehicles. Performed examination manages two instances of braking; the primary case considers braking to a halt; the second case considers braking on a slope and keeping up a steady speed. In the two cases the fundamental limit condition is the heat transition on the braking surfaces and the holding power of the brake calipers. Likewise the radial load is considered. Limited component technique (FEM) approach is been utilized, 3D show has been demonstrated for examination. Brake plate material is adjusted graphite; two sorts of circle considered for concentrates one without wear and one with 7mm wear on the two sides. Greatest speed is 250 km/hr and the encompassing and beginning circle and encompassing temperature is 50 C Temperatures and worry in plates under diverse burdens are high.

### III. CONCLUSION

Disc brake design plays as an important role in heat transfer as other variable like plate & vane thickness, fin material and flow pattern. There is a scope of improvement in heat transfer in ventilated disc brake if vane is angled and of alternate length other than straight radial vane. Contact time between air flow and vanes (time between air inlet and outlet flow through vanes) is also important factor in heat transfer from Disc rotor. There is also scope of research in improvement of heat transfer of rotor by increasing the contact time between vanes and air flow by design modification of vanes in such a way that fulfills the requirement.

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