IJARETY

International Journal of Advanced Research in Education and TechnologY (IJARETY)

Volume 12, Issue 3, May-June 2025

Impact Factor: 8.152

www.ijarety.in editor.ijarety@gmail.com

International Journal of Advanced Research in Education and TechnologY(IJARETY)

| ISSN: 2394-2975 | www.ijarety.in| | Impact Factor: 8.152| A Bi-Monthly, Double-Blind Peer Reviewed & Refereed Journal |

|| Volume 12, Issue 3, May - June 2025 ||

DOI:10.15680/IJARETY.2025.1203112

Modeling and 3D Printing of 4 Wheeler Disc Plate

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ABSTRACT: A disc brake is a type of brake that uses calipers to squeeze pairs of pads against a disc in order to create friction that retards the rotation of a shaft, such as a vehicle axle, either to reduce its rotational speed or to hold it stationary. The energy of motion is converted into waste heat which must be dispersed. Hydraulic disc brakes are the most commonly used form of brake for motor vehicles but the principles of a disc brake are applicable to almost any rotating shaft.

In this project the model is Designed with respect to all the available constraints using an advanced cad software's like Creo parametric, solid works, Catia and solid edge.Later the product file is converted to ".stp" file format (standard exchange of product file) and imported to ansys workbench to find deformation and analytic valve with respect to the model or product definitions. By using 3D Printing Technology, we will create a prototype of (project) to check with design.

I. INTRODUCTION OF DISC BRAKE

A **disc brake** is a type of brake that uses calipers to squeeze pairs of pads against a disc in order to create friction that retards the rotation of a shaft, such as a vehicle axle, either to reduce its rotational speed or to hold it stationary. The energy of motion is converted into waste heat which must be dispersed. Hydraulic disc brakes are the most commonly used form of brake for motor vehicles but the principles of a disc brake are applicable to almost any rotating shaft.Compared to drum brakes, disc brakes offer better stopping performance because the disc is more readily cooled. As a consequence discs are less prone to the brake fade caused when brake components overheat. Disc brakes also recover more quickly from immersion (wet brakes are less effective than dry ones).Most drum brake designs have at least one leading shoe, which gives a servo-effect. By contrast, a disc brake has no self-servo effect and its braking force is always proportional to the pressure placed on the brake pad by the braking system via any brake servo, braking pedal, or lever. This tends to give the driver better "feel" and helps to avoid impending lockup. Drums are also prone to "bell mouthing" and trap worn lining material within the assembly, both causes of various braking problems.

The brake disc (or rotor in American English) is usually made of cast iron, but may in some cases be made of composites such as reinforced carbon–carbon or ceramic matrix composites. This is connected to the wheel and/or the axle. To retard the wheel, friction material in the form of brake pads, mounted on the brake caliper, is forced mechanically, hydraulically, pneumatically, or electro-magnetically against both sides of the disc. Friction causes the disc and attached wheel to slow or stop.

II. LITERATURE REVIEW

Piotr GRZEŚ [1] The aim of this paper was to investigate the temperature fields of the solid disc brake during short, emergency braking. In this paper transient thermal analysis of disc brakes in single brake application was performed. To obtain the numerical simulation parabolic heat conduction equation for two dimensional model was used. The results show that both evolution of rotating speed of disc and contact pressure with specific material properties intensely effect disc brake temperature fields in the domain of time.

Abd Rahim Abu-Bakar, Huajiang Ouyang [2] This paper studies the contact pressure distribution of a solid disc brake as a result of structural modifications. Before modifications are simulated, four different models of different degrees of complexity for contact analysis are investigated. It is shown that the contact pressure distributions obtained from these four models are quite different. This suggests that one should be careful in modeling disc brakes in order to

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obtain correct contact pressure distributions. This work could help design engineers to obtain a more uniform pressure distribution and subsequently satisfy customers' needs by making pad life longer.

M. Nouby, D. Mathivanan, K. Srinivasan [3]proposes an approach to investigate the influencing factors of the brake pad on the disc brake squeal by integrating finite element simulations with statistical regression techniques. Complex Eigen value analysis(CEA) has been widely used to predict unstable frequencies in brake systems models. The finite element model is correlated with experimental modal test. The 'input-output' relationship between the brake squeal and the brake pad geometry is constructed for possible prediction of the squeal using various geometrical configurations of the disc brake. Influences of the various factors namely; Young's modulus of back plate, back plate thickness, chamfer, distance between two slots, slot width and angle of slot are investigated using design of experiments (DOE)technique. A mathematical prediction model has been developed based on the most influencing factors and the validation simulation experiments proved its adequacy.

P. Liu a, H. Zheng a, C. Cai a, Y.Y. Wang a, C. Lu a,K.H. Ang b, G.R. Liu [4] An attempt is made to investigate the effects of system parameters, such as the hydraulic pressure, the rotational velocity of the disc, the friction coefficient of the contact interactions between the pads and the disc, the stiffness of the disc, and the stiffness of the back plates of the pads, on the disc squeal. The simulation results show that significant pad bending vibration may be responsible for the disc brake squeal. The squeal can be reduced by decreasing the friction coefficient, increasing the stiffness of the disc, using damping material on the back plates of the pads, and modifying the shape of the brake pads.

III. METHODOLOGY

This methodology explains the step by step process which are carried out to accomplish the completion of entire modeling and 3d printing of 4 wheeler disc plate.

Using Solid works, the computer model of disc plate will be designed. The 3D-model design is then printed by using the 3D printer. The 3D model of disc plate is printed by using Fused deposition Modelling technique. Acrylonitrile butadiene styrene (ABS) and Polylactic acid (PLA) are basically used material for preparing a model in 3D printing. The use of 3D printing technology allowed for the customization of the disc plate design and the creation of complex geometries that would be difficult or impossible to produce using traditional manufacturing method

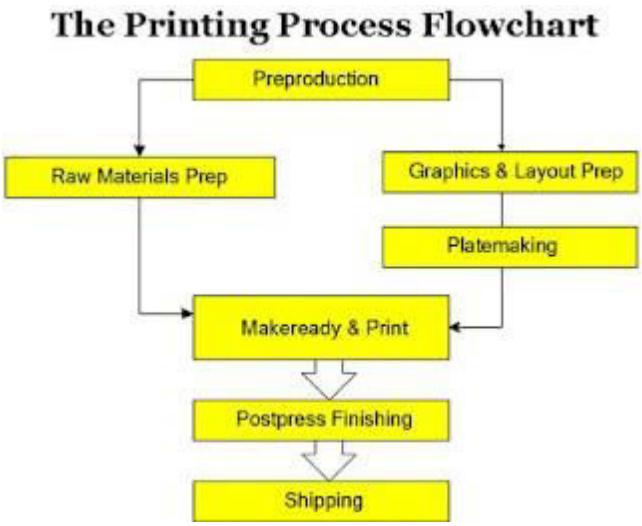

Fig- printing process flow chart

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3D MODEL OF DISC PLATE

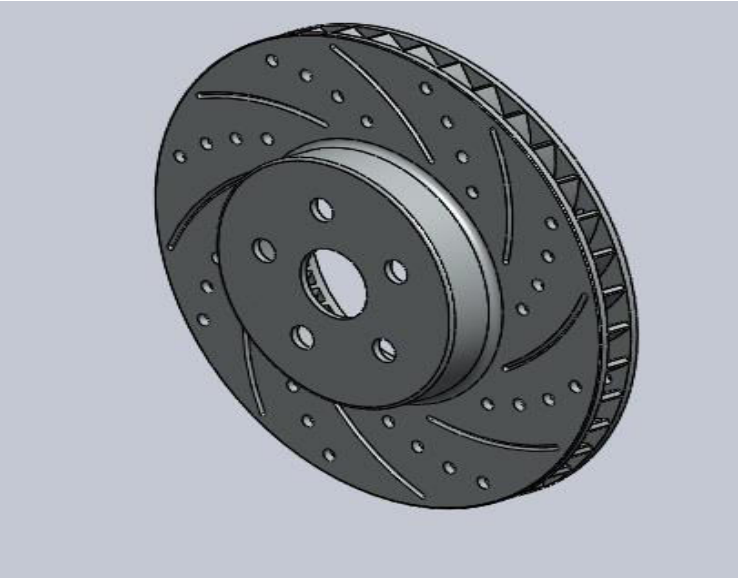

FIGURE 4. 20 DISC BRAKE

IV. CONCLUSION

The project successfully modeled and analyzed a 4-wheeler disc brake system by employing advanced computer-aided design (CAD) tools such as SolidWorks for 3D modeling and ANSYS Workbench for simulation and analysis. The disc brake design was meticulously developed to reflect realistic operational dimensions and constraints, integrating essential features such as ventilation holes, grip gaps, and structural supports. These elements not only enhanced the visual and functional design but also played a critical role in improving heat dissipation and maintaining structural integrity under braking conditions. Structural analysis revealed that the stresses and deformation experienced by the model under braking loads were within acceptable safety margins, ensuring mechanical stability. Thermal analysis further confirmed that the disc brake could manage the temperature rise caused by friction during braking without failure or material degradation. These findings are consistent with existing studies and literature, validating the accuracy and relevance of the modeling approach used. Additionally, the final model was refined to be compatible with 3D printing processes, enabling the creation of a physical prototype for demonstration or testing purposes. Despite these achievements, the current study focused solely on static loading conditions and basic thermal assessments, thereby limiting the understanding of the brake's behavior under dynamic and real-world scenarios. To address these gaps, future work is recommended to involve dynamic braking simulations, fully coupled thermo-mechanical analysis, and advanced material studies exploring the use of lightweight composites such as carbon fiber or ceramic matrix materials. Moreover, fabricating the model using additive manufacturing and conducting physical tests could validate simulation results and reveal practical performance insights. Further investigation into long-term effects such as wear, fatigue, scarring, and vibration (NVH – noise, vibration, and harshness) will also be essential to comprehensively evaluate the durability and efficiency of the brake system in real operational environments.

V. ACKNOWLEDGEMENT

We would like to express our sincere gratitude to our internal guide, Ms. D.Prasuna Lilly Florence, Assistant Professor, Mechanical engineering, for his valuable guidance, encouragement, and continuous support throughout the duration of this project.We are also thankful to Dr. A. Raj Kumar, Head of department, Mechanical engineering, for his expert supervision and helpful suggestions, which contributed significantly to the successful completion of this project. We would also like to thank the faculty members of the **Mechanical engineering** and the Lab Technicians for their assistance and cooperation during the practical work of our project. We are grateful to our friends and well-wishers for their encouragement, collaboration, and useful feedback throughout the project

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journey.565Lastly, we sincerely thank our parents for their constant support, patience, and motivation, which helped us complete this project successfully.

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ISSN: 2394-2975 Impact Factor: 8.152

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