DESIGN AND ANALYSIS OF BRAKING SYSTEM FOR ELECTRIC GO-KART

S. Madhu[1], C. Rahul[2], M. Sai Ram[3], P. Sai Santhosh[4]

[1]Assistant professor, Department of Mechanical Engineering, GNIT, Hyderabad, Telangana
[2,3,4,] UG Scholars, Department of Mechanical Engineering, GNIT, Hyderabad, Telangana

---***---

Abstract

This study presents a comprehensive approach to the design and analysis of a braking system for an electric go-kart application. The goal is to develop a braking system that provides optimal performance, reliability, and safety while leveraging the design capabilities of SolidWorks and the advanced simulation capabilities of ANSYS.

The design process begins with defining the requirements for the braking system, considering factors such as the kart's weight, speed, and braking performance expectations. Extensive research has been conducted to understand the existing braking systems on go-karts and gain valuable insight into design principles and best practices.

The components of the braking system are designed in detail using SolidWorks. This includes the design of the brake pedal, brake disc, hub, and push rod. Each component is manufactured to meet specified requirements and ensure compatibility with the overall design of the electric go-kart.

Key Words: Solid Works, braking system, go-kart, ANSYS

1. INTRODUCTION

The brake system slows the rotation of the wheels when you press the brake pedal, slowing the vehicle down.

1.1 Brake system principle:

The brakes function according to the principles of Pascal's law. According to this law, when some pressure is applied to a fluid, the fluid moves equally in all directions. When you apply pressure to the brake fluid, this pressure is transferred to the piston in the brake caliper, which activates the brake pads to stop the discs and slow the cart.

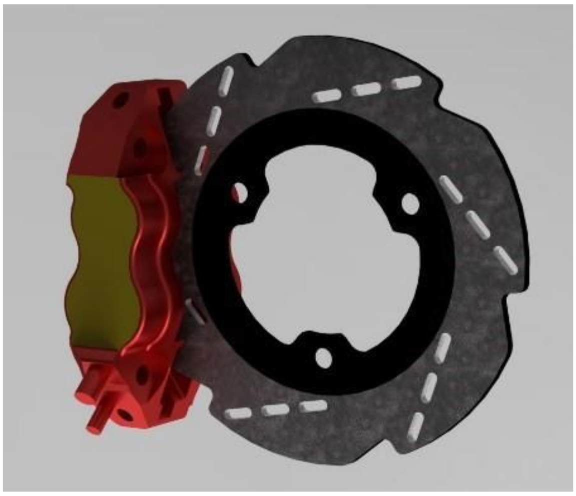
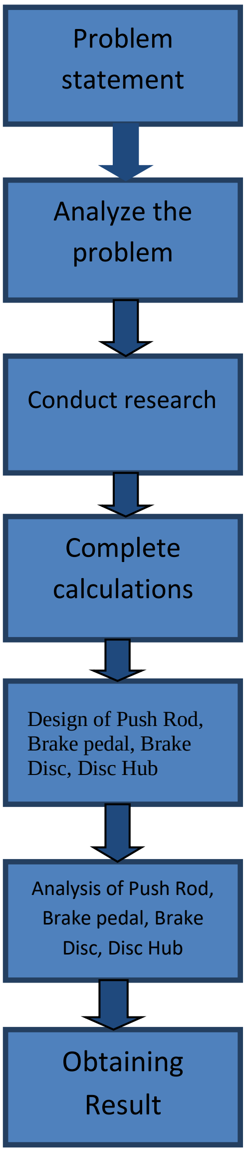


Fig 1: Calliper with disc

Brake Components:

1. Brake Pedal
2. Push Rod
3. Master Cylinder
4. Hose Pipe
5. Brake Calliper
6. Brake Disc
7. Disc Hub
8. Brake pads

METHODOLOGY:



MATERIALS:

Different types of disc materials:

Brake discs are an important part of a vehicle's braking system, providing the friction surface against which the brake pads press to slow the rotation of the wheel. In comparison to a bicycle, the bicycle rim performs the same function as the brake disc. When the bicycle brake pads compress the rim, it slows you down. The situation is similar in a vehicle. When you apply the brakes, the brake pads clamp onto the brake disc, which must function properly to stop the vehicle.

If the brake disc overheats, it can increase the stopping distance and deteriorate the brake pads. This can cause serious problems with braking and stopping, increasing the safety risk to yourself and other road users. Here's a breakdown of the different types of brake discs to help you decide which one is best for your car.

Table 1: Brake fluids:

Type of Fluid	Base	Wet Boiling Point	Dry Boiling Point
DOT 3	Glycol	284°F (140°C)	401°F (205°C)
DOT 4	Glycol	311°F (155°C)	446°F (230°C)
DOT 4 Super	Glycol	383°F (195°C)	509°F (265°C)
DOT 5	Silicone	365°F (185° C)	500°F (260°C)
DOT 5.1	Glycol	365°F (185°C)	500°F (260°C)

DESIGNING:

Design:

SOLIDWORKS is a design automation software. With Solid Works, sketch your ideas, experiment with different designs, and create 3D models. Solid Works is used by students, designers, engineers, and other professionals to create simple and complex parts, assemblies, and drawings.

Terminology:

These terms are used throughout Solid Works software and documentation.

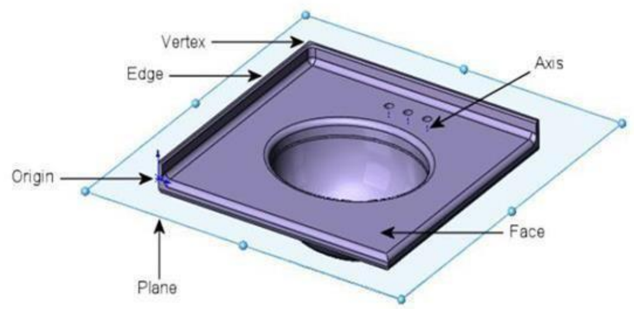


Fig 2: Model terminology

International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 04 | April - 2024 SJIF Rating: 8.448 ISSN: 2582-3930

Designing process of disc rotor:

1. Go to Functions, select the subdiagram, and click OK.

2. Change dimensions to MMGS. Go to your sketch and select the front layer. 26

3. Use the Circle and Smart Dimension commands to draw a circle with a diameter of 221 mm, and use the Projection command to extrude the circle to 10 mm.

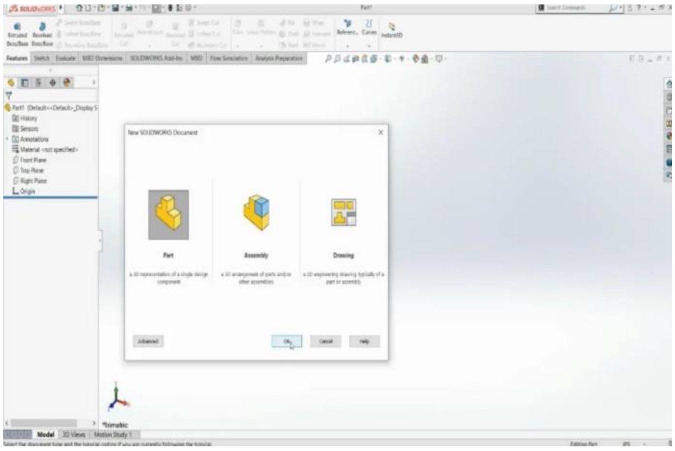


Fig 3: selection of solid work document

4. Now draw another circle with a diameter of 133 mm, select the join result and extrude it to 35 mm.

5. Using the Circle command and smart dimensions, draw another circle by selecting the back phase of the plane with a diameter of 123 mm. Then click Extrude and Cut All.

6. Select the reference plane and add holes according to the required dimensions.

7. Next, use smart dimensions to create a circle with a diameter of 133 mm on a new layer and extrude it using the Extrude Boss command (do not merge).

8. Next, draw a circle on the extrusion surface and select Extrude, Cut All.

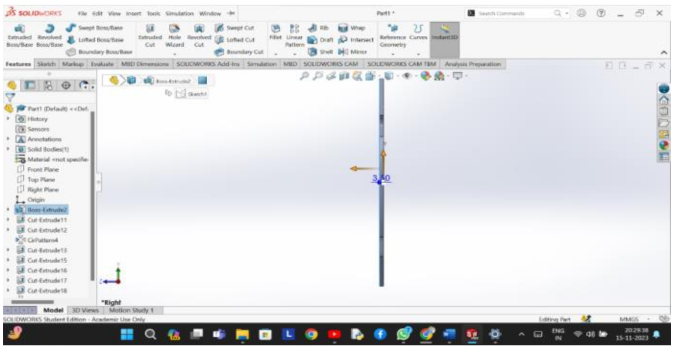


Fig 4: Extruded part

9. Using the Circle command and smart dimensions, draw three 10 mm diameter circles on the same surface, spaced 50 mm apart from the center.

10. Next, draw a circle on the extrusion surface and select Extrude, Cut All.

11. Draw three 10 mm diameter circles on the same surface at a distance of 50 mm from the center using the Circle and Smart Dimension commands.

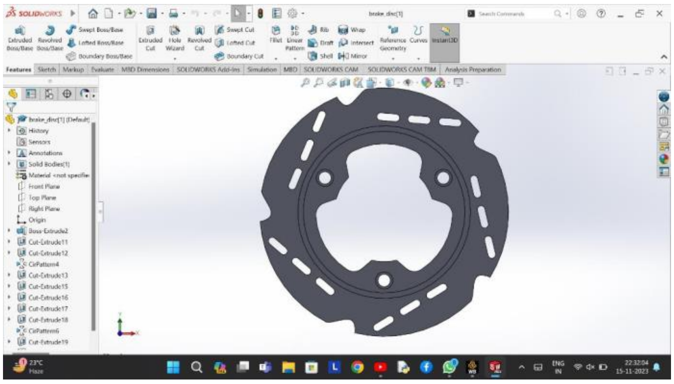


Fig 5: Final design

Brake Pedal Design Process:

1. Go to Features, select Parts Drawing, and click OK.
2. Change dimensions to MMGS. Go to your sketch and select the front layer.

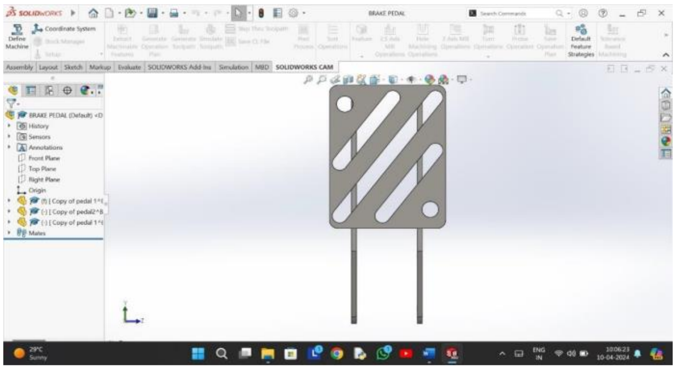


Fig 6: Front View

3. Use the Line and Smart Dimension commands to draw a line 150 mm long, and use the Extrude Floor command to extrude the line to 10 mm.

4. Next, use the trim command to trim the ends of the rectangular bar to get the desired shape.

5. Then cut out the holes and spaces needed to reduce weight.

6. Create another rectangular shape for the mold, if desired.

7. Extrude the square bar to a height of 10mm and assemble it to the previous part.

8. Next, extrude the edges of the composite part and make sure it is joined as one part.

9. Once the design is complete, enter the dimensions of the design.

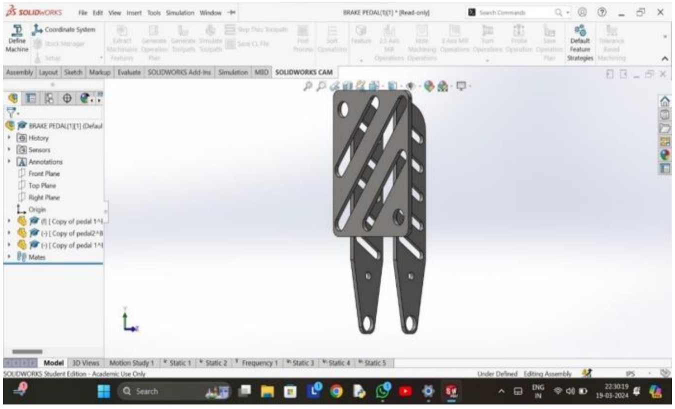


Fig 7: Isometric View

Pushrod Design Process:

1. Go to Features, select the subdiagram, and click OK.

2. Change dimensions to MMGS. Go to your sketch and select the front layer.

3. Use the Circle command to draw a circle and extend it according to your design requirements.

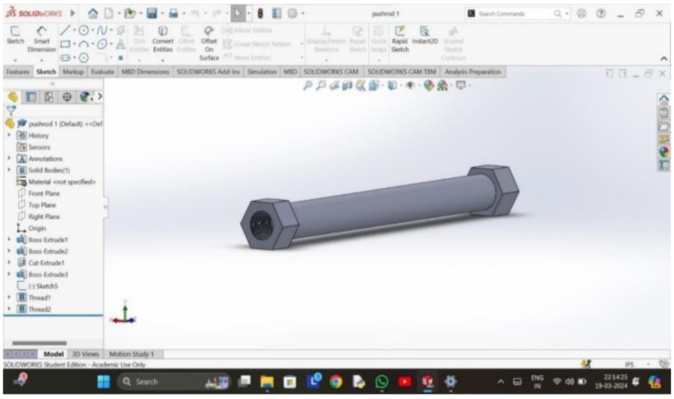


Fig 8: Isometric View of Push Rod

4. Next, use another model to design two hex nuts on the end of the push rod. Design hex nuts as required.

5. Assemble the cylinder tube and mounting nut into the specified shape.

6. Next, check the dimensions of the entire design.

7. Add the material and save the file to your system.

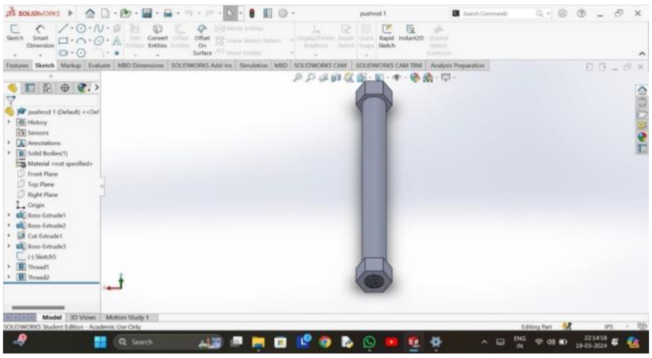


Fig 9: Top view of push rod

Disk Hub Design Process:

1. Go to Functions, select the subdiagram, and click OK.

2. Change dimensions to MMGS. Go to your sketch and select the front layer.

3. Draw a circle to measure the brake disc. Extend the circle to the required dimensions.

4. Now select a plane on the surface of the extension part.

5. The extruded parts are then cut to create holes in the design and other parts are assembled.

6. Expand the circle on the selected surface to get the desired shape.

7. Add holes for screws.

8. Assemble these to get the desired hub.

9. Check the overall design dimensions and add materials.

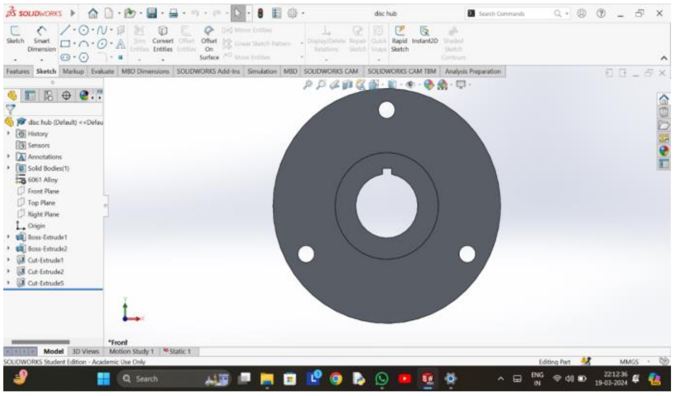


Fig 10: Front view of disc hub

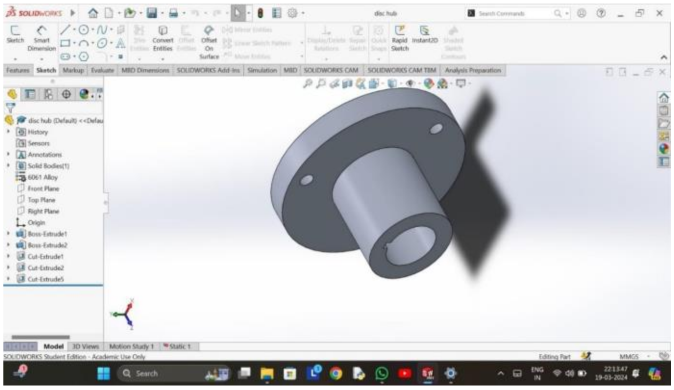


Fig 11: Isometric view of disc hub

Results: The maximum strain developed in the disc was 2.6e-003 and the minimum stress developed was 3.33e-006.

International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 04 | April - 2024 SJIF Rating: 8.448 ISSN: 2582-3930

Brake Disc Safety Factor:

Geometry and Meshing: Import or create brake disc geometry and generate a mesh to accurately simulate its structure.

Material Properties: Brake disc materials such as: Define the characteristics. Examples: Young's modulus, Poisson's ratio, etc.

Load Conditions: Apply realistic loads such as: B. Braking forces and constraints that simulate the actual operating conditions of the disc.

Analysis Type: Select the appropriate analysis type (static structure analysis) and configure the simulation settings.

Run Solver: Run the simulation to calculate the stresses and strains in the brake disc.

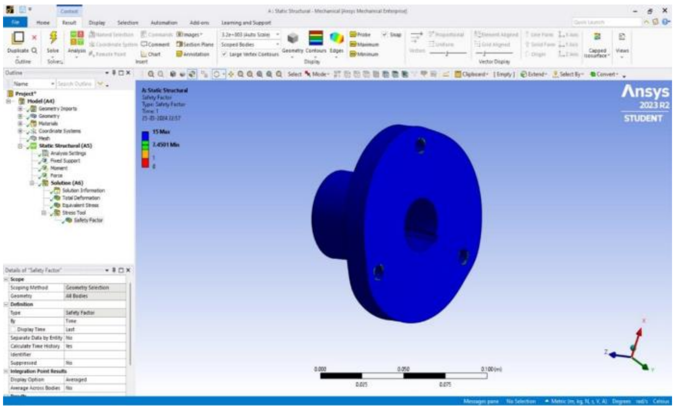


Fig 12: Factor of safety of disc hub

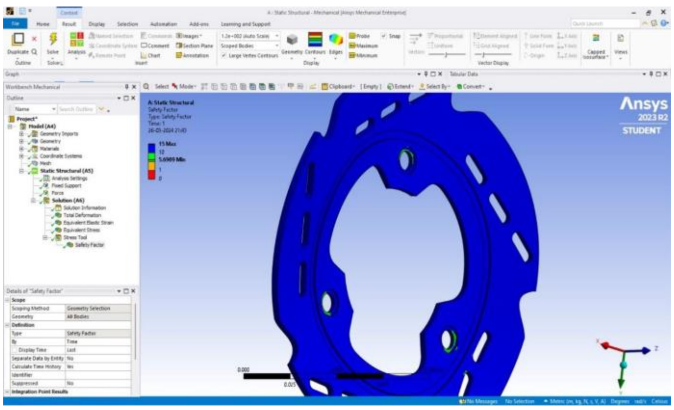


Fig 13: Factor of safety of brake disc

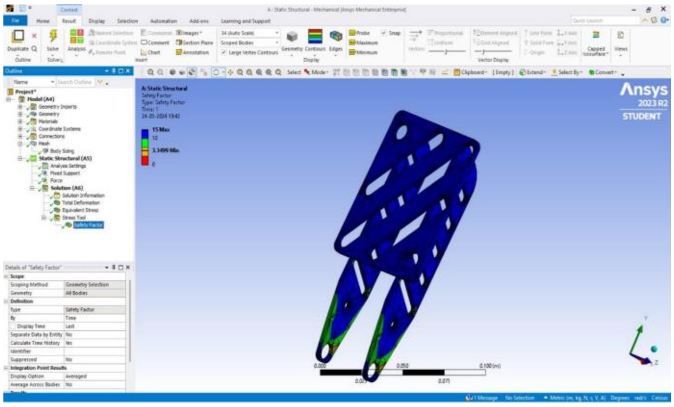


Fig 14: Factor of safety of pedal

Run the solver: Run the simulation to calculate the stress distribution in the brake disc.

Post-processing: Use ANSYS post-processing tools to analyze and visualize the entire equivalent stress distribution across the brake disc and identify areas with the highest stress levels.

This procedure helps engineers evaluate the stress distribution within the brake disc. This is important to ensure structural integrity and durability under braking conditions.

Result: The maximum stress developed in the disk is 5.16e8 and the minimum stress is 4.86e5.

RESULTS AND DISCUSSION:

We've worked hard to develop and test our electric go-kart braking systems to make sure they work really well, keep everyone safe, and don't cost a lot of money. We started by determining exactly how the brakes should work. For example, how quickly to stop the cart, how the brakes work depending on the cart's speed and weight, etc. Then there are the different parts of the braking system, including: B. Brake discs and pads are carefully selected to work together perfectly. We tested everything on the computer to simulate different braking situations and also tried it out on a real prototype kart to see how it actually behaves. It was very important to us to make sure the brakes were very safe. We wanted to make it easy for them to deal with any emergency and made sure that all important safety rules and standards were followed. We also looked at how much it costs to buy and maintain brakes.

Fig 15: Electric Vehicle

CONCLUSION:

When designing and analyzing the braking system of electric go-karts, its important role in ensuring safety and performance was emphasized. We followed a structured design approach and evaluated factors such as braking distance, deceleration, and safety features against industry standards. Although our system met many criteria, we identified areas for improvement and suggested possible component optimizations and further testing. Security remains our top priority and we have driven continuous improvements to ensure user protection and system reliability. Future research may explore new materials and techniques to improve performance and safety. This research lays the foundation for further advances in electric go-kart braking systems, ultimately improving overall safety and performance.

ACKNOWLEDGEMENT:

We wish to convey our sincere thanks to our internal guide **Mr. S. MADHU**, Assistant Professor, Department of Mechanical Engineering, for his professional advice, encouragement in starting this project and academic guidance during the course of this project.

We wish to convey our sincere thanks to **Dr. B. VIJAYA KUMAR**, Professor & Head of Department, Department of Mechanical Engineering for his masterly supervision and valuable suggestions for the successful completion of our project.

We wish to express our candid gratitude to Principal **Dr. S. SREENATHA REDDY,** and the management for providing the required facilities to complete our project successfully.

We convey our sincere thanks to the staff of Mechanical Engineering Department and the Lab Technicians for providing enough stuff which helped us in taking up the project successfully.

We are also grateful to our well-wishers and friends, whose co-operation and some suggestions had helped us in completing the project.

Finally, we would like to thank our parents for their exemplary tolerance and giving us enough support in our endeavours.

REFERENCES:

[1] G. Babukanth : "Transient Analysis of Disk Brake by using ANSYS Software"
International Journal of Mechanical and Industrial Engineering, Vol-2, PP 21-25,
2012.
https://www.researchgate.net/publication/325719723_Strength

[2] Mahmood Hasan Dakhil : Structural Design and Analysis of Disc brake i n
Automobiles.
https://www.researchgate.net/publication/274373222_Structural

[3] K.Sowjanya : Structural Analysis of Disc Brake Rotor
https://www.scribd.com/document/225772759/Structural-Analysis-of-Disc-Brake-Rotor

[4] Shaik Himam Saheb :“Design and Structural Analysis of Brake Disc by Varying Brake Pressure”, International Conference on Trends in Material Science and Inventive Materials, page no:1-9, 2020. https://www.researchgate.net/publication/345932329

[5] Lemi Abebe :“THERMAL ANALYSIS OF DISC BRAKE MADE OF DIFFERENT MATERIALS. https://www.researchgate.net/publication/307890307

[6] Rajat S Panday : This paper analyzes and optimizes the design of the disc brake system for a Go-kart. http://www.ijirset.com/upload/2017/april/8

[7] Ashirbad Sahoo: This journal article focuses on analyzing and designing braking systems for All Terrain Vehicles (ATVs) and Go-karts worldwide.. https://iaeme.com/MasterAdmin/Journal_uploads/IJMET/VOLUME

[8] Akshat Sharma : This research aims to optimize brake disc design for improved vehicle performance and safety in various conditions.https://www.worldwidejournals.com/paripex/recent_issues_pdf/2013/March/braking-systems--past-present--future_March_2013_3139056094

[9] Harish Kumar Garg : The automotive industry increasingly favors aluminium metal matrix composites (AMMCs) for lightweight components, addressing challenges in the sector. A novel hybrid material, (Al6061/SiC/Gr), has been developed to enhance braking systems. https://www.researchgate.net/publication/265888167_Hybrid_Metal_Matrix_Composites_and_further_improvement_in_their_machinability-A

[10] Dr. A.H.Ingle : Unlike traditional brakes, they use electric and magnetic power for braking action, controlled manually. https://ijaem.net/issue

[11] Mr. Akshaya : Traditional braking systems rely on friction to convert kinetic energy into heat, but frequent use can lead to decreased effectiveness due to elevated brake pad temperatures. https://www.ijert.org/research/review-paper-oneddy-current-and-electromagnetic-brake
49

[12]ANNE.NAVEEN BABU : In conclusion, the braking system is crucial for automobile safety, facilitating speed reduction and stops. Efficient operation is vital, necessitating prevention of mechanical, thermal, vibrational, or fatigue failures.

[13]Ashirbad Sahool : Design Analysis and Calculations of an Optimized Braking System https://www.irjet.net/archives/V7/i11/IRJET

[14]Karthikeyan S : :Design and Analysis of Brakes in Go-kart Vehicle**.** https://www.sae.org/publications/technical-papers/content/2023-01-5168

[15] Anderson : "Analysis of Thermal Management Systems for Electric Vehicle

Braking." Applied Thermal Engineering, 120, 689-702.

[16] Mr. Abhijeet : Selection of Braking system for go cart.
https://ijariie.com/AdminUploadPdf/Selection of Braking system for Go Cart

[17] Kishan D. Patel : Design and Analysis of a Go-Kart Braking System In today's
racing world, speed often steals the spotlight, but braking is just as crucial,
especially in high-speed karting.
https://www.researchgate.net/publication/374420541 Design and Analysis of a Go-Kart Braking

[18] G.Bbukanth,M.Vimla Teja :"Transient Analysis of Disk Brake by using
Ansys Software", International Journal of Mechanical and Industrial
Enginnering,Vol-2 PP 21- 25,2012

[19] okuma , and Didigwu C.G : Modeling and simulation analysis of racing Gokart-
https://gjeta.com/sites/default/files/GJETA-2022

[20] **Ankur Rai, Daksh Dutt, Manish Ryka, Brahma Nand Agarw [20]:**
Design and Optimization of Brake Disc for Two-Wheeler Braking System.
https://www.springerprofessional.de/en/design and optimization of brake disc for two wheeler braking

[21] KARTHIK T R : Design Analysis and Optimization of Disc Brake (Two
Wheeler)
https://www.ijatir.org/uploads/231546IJATIR13011

[22] Sanjay pawar : Analysis of Electromagnetic Braking System.
https://www.researchgate.net/publication/362518397 Analysis of Electromagnetic Braking

[23] Rajkumar M: Design Optimization and Analysis of Braking System of Go-Kart.
https://www.researchgate.net/publication/345650470 Design Optimization and Analysis of Braking System of Go

[24] Dr. Sarah L. Garcia : Specializing in mechatronics and electrical engineering,
Dr. Garcia's research may focus on the design and implementation of regenerative
braking systems for electric go-karts to improve energy efficiency and extend
50
battery life.
https://www.researchgate.net/publication/335780107_Brake_discs_A_technological_review_from_its_analysis_

[25] Anurag Parag Borse : Design and Analysis of Brake Rotor (DISC) In
conclusion, disc brakes play a vital role in vehicle safety by slowing or stopping
motion through friction. performance for vehicles.
https://www.irjet.net/archives/V6/i8/IRJET

[26] Dr. B. Vijaya Kumar: Design and Fabrication of Composite Material Body
Parts for EV Go-
Kart.https://ijaem.net/issue_dcp/Design%20and%20Fabrication%20of%20Composite%20Material%20Body%20Parts%20for%20EV%20Go