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An Approach to Design & Develop a Prototype of Electromagnetic Braking System

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Abstract: Electronic and magnetic power are used to apply the brakes during electromagnetic braking. Here, we apply the electromagnetic concept to brake with reduced friction. Since there is reduced friction, the lifespan and dependability of brakes are likely to rise as a result. Additionally, it requires less oiling and maintenance. This is a future technological advancement that will replace conventional braking methods. The fact that these brakes are frictionless is the fundamental justification for their proposed usage in automobiles. Due to the lack of friction and oiling, maintenance costs are significantly reduced. Additionally, conventional braking systems are prone to slippage, whereas this one ensures that the car will be stopped. Therefore, this technique is a favored replacement for conventional brakes because it doesn't require friction or lubrication. In comparison to conventional braking systems, it is also considerably smaller in size.

In order for electromagnetic brakes to function, a magnetic flux must be passed in a direction perpendicular to the direction in which the wheel is revolving. This causes eddy current to flow in the direction in which the wheel is not rotating. As a result, the wheel rotates more slowly because of an opposing force. As a result, electromagnetic braking is developed as a superior braking mechanism for cars of the future.

Index-Terms **– Frictionless, Magnetic, Braking Arrangement & Eddy Current.**

I. INTRODUCTION

As everyone is aware, a car has many different sorts of systems, including lighting, ignition, air conditioning, etc. The braking system is one of the most crucial systems out of all of these systems.

You should be familiar with all of these systems as a mechanical engineer, so let's start with the brake system today. Let me start by explaining what a brake system is all about.

The incidence of unintentional deaths increased throughout the years 2003 to 2012, rising by 51.8% in 2012 compared to 2002, but a 0.2% decline was noted in 2003 compared to the year before. While the rate of accidental deaths increased throughout the years 2003 to 2012, the population growth during that time was just 13.6%. 4,098 more unintentional fatalities than those reported in 2011 were recorded in the nation in 2012, bringing the total to 3,94,982, representing an increase of 1.0% from 2011. Accordingly, there was a 0.3% increase in the population and a little increase in the rate of "Accidental Deaths" this year compared to 2011.

1.1 DEFINITION OF BRAKE SYSTEM

One of the most crucial car controls is the brake. This combines a few interactive elements. It takes energy from the moving component and uses friction to slow the vehicle down. To stop a vehicle, each has a unique braking system. I've listed some of the typical car braking systems below.

Functions of the Brake System: The brake system's purpose is to stop the vehicle in the shortest amount of time feasible. To accomplish this, it transforms the vehicle's kinetic energy into thermal energy, which is released into the atmosphere.

1.1.1 Automobile Brake System Types: The following categories can be used to group braking systems in automobiles. One, Mechanical Brake, Disc Brakes, Third, hydraulic brake, the use of power brakes, Five. Air Brake, Electricity and System for hand brakes.

II. Problem Statement

According to an Indian survey, accidents now account for a significant portion of fatalities; each day, 1000 new incidents are reported, the majority of which result in injuries and 50% of which result in fatalities. Therefore, we need to establish a mild braking system in order to avoid these incidents. Even with two-wheelers, there is an issue with the disc plate wearing out when it comes into direct contact with the calipers, which shortens the braking life and increases the likelihood of an accident. Our solution assists in better braking and contactless brake adoption to address these two issues.

III. Objective For The Problem

- To investigate various data to support our project work, such as the issue we are having? What kind of systems do we employ? What kinds are there? etc.
- Material selection for our project.
- Analytically determine the component parameters for propagation as needed.
- To create a development model with the aid of CATIA v5 software
- Analysis of the component in market.
- Buying parts in accordance with specifications.
- To build the model and evaluate its usefulness.
- primarily to decrease accidents by utilizing methods or technologies that are currently available.
- To investigate if a magnetic or electric braking system is worthwhile.

IV. Proposed System for Problem

An eddy current is produced when a non-magnetic conductive material interacts with a magnet while the material is rotating, creating an opposing force in the direction of the axis. To resist the rotating aluminium disc plate in this instance, a magnet is positioned. The loop system of safety precautions is used for all to congregate. braking system utilizing magnetic conduction to slow down the rotating aluminum disc plate.

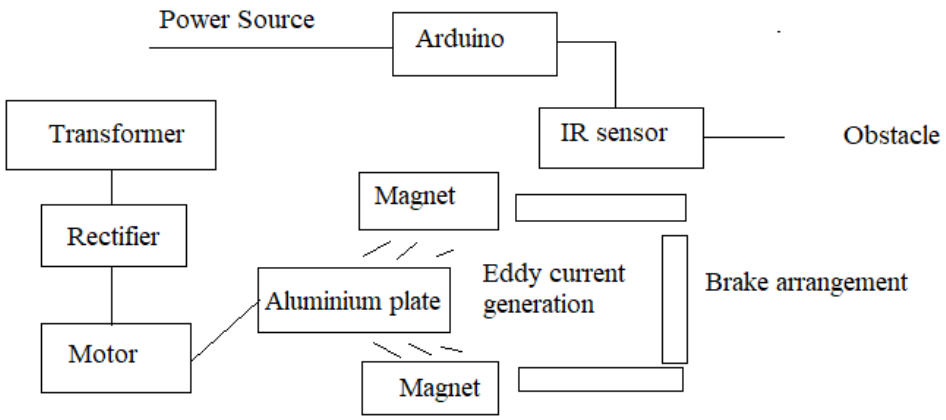


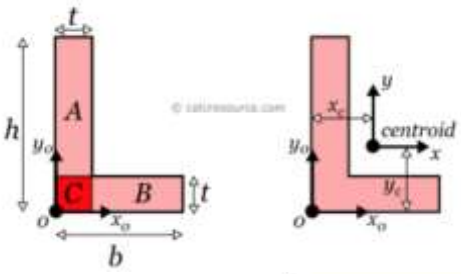
Figure 4.1 Proposed System Schematic Representation.

- This is an idea representation of the braking system by designing & developing it. The following procedures helps in understanding the theory behind prototyping a Frictionless Electromagnetic braking system.

V. Calculation's, Designs & Components required

5.1 Design of Frame Angle (L-Angle frame). Analytically Calculating The Frame Mounts Bending Stress To Prototype A System

- If the overall area is divided into three smaller ones, A, B, and C, as illustrated in the picture below, the moments of inertia of an angle can be calculated.
  The final area can be thought of as the sum of areas A, B, and C. If the formula (A+C)+(B+C)-C is used, the calculation is easier to understand.
- The angle's moment of inertia, Ix0, with respect to axis x0 is then calculated as follows:



$$I_{x0} = I_{x0}^{A+C} + I_{x0}^{B+C} - I_{x0}^{C} \Rightarrow$$
$$I_{x0} = \frac{bt^3}{3} + \frac{th^3}{3} - \frac{t^4}{3} \Rightarrow$$
$$I_{x0} = \frac{t}{3}\left(bt^2 + h^3 - t^3\right)$$

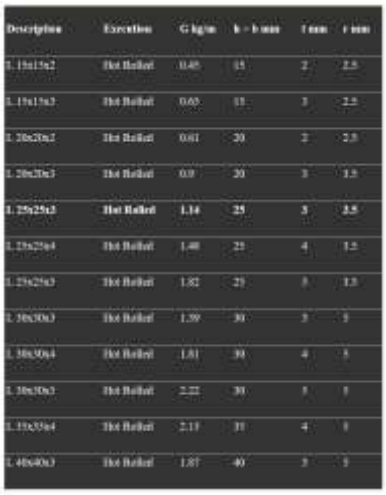


Figure 5.1 a, b, c MoI of L-angle Frame & Standard sizes (Online Source).

5.1.1 Frame Bending calculations

- 25*25*3 mm rectangular cross-section According to standard availability in the market

Selection idea behind it.

Cost effective, highly tensile in nature compared to normal rectangle plates. L-Angle joint provides extra rigidity and spacr for our project.

- Therefore, to calculate the Moment of inertia of a L-Angle Bar we require Following Specifications.
- t = 3mm
- B = 25mm
- H = 25 mm

$$Ixx = \frac{t}{3} * (bt^2 + h^3 - t^3) = 15823\ mm^3$$

$$Assume\ load\ on\ the\ frame\ including\ all\ components\ =\ 10\ Kg\ +\ 5Kg\ extra\ load = 15\ kg$$

$$Total\ mass\ on\ frame\ = 15 * 9.81 =\ 147.15\ N$$

$$FOS\ = 1.5 = 147.15\ X\ 1.5 = 220.75\ N\ =\ 250\ N$$

$$Distance\ =\ 506\ mm$$

$$Perpendicular\ distance = 506\ /\ 2 = 253\ mm$$

$$Max\ Bending\ Moment = 250\ X\ 253 = 63250\ N - mm$$

$$M = 63250\ N - mm$$

$$I = 15823\ mm\text{^}3$$

$$Y\ = Distance\ of\ the\ layer\ at\ which\ the\ bending\ stress\ is\ consider = 25/2\ =\ 12.5\ mm$$

$$Sigma\ b = M\ X\ Y\ /\ (I)$$

$$M = 63250\ N - mm$$

$$I = 15823\ mm\text{^}3$$

$$Y = 12.5$$

$$Sigmab = \frac{63250 * 12.5}{15823} = 49.96\ MPa$$

5.2 Design of Shaft

Diameter of shaft = 15mm

Because it is easily available in the market

Length = 350 mm

$$Ixx = \left(\frac{\pi}{4} * r^4\right) = 2485.04\ mm^2$$

$$From\ online\ \ it\ has\ found\ that\ wheel\ weight\ as\ 5 - 10\ kg\ so\ we\ will\ design\ for\ maximum\ 10\ Kg\ = 10 * 9.81 = 98.1\ N = 100N$$

$$Perpendicular\ distance =\ 350/\ 2 = 175\ mm$$

$$Max\ Bending\ Moment = 100\ X\ 175 = 17500\ N - mm$$

$$M = 22500\ N - mm$$

$$I = 2485.04\ mm2$$

$$Y = Distance\ of\ the\ layer\ at\ which\ the\ bending\ stress\ is\ consider = 15/2 = 7.5\ mm$$
$$Sigma\ b = M\ X\ Y\ /\ (I)$$
$$= 17500\ X\ 7.5\ /\ (2485.04)$$
$$= 52.81\ MPa$$
$$52.810 < Steel\ Ultimate\ Yield\ Strength\ Hence\ Design\ is\ safe.\ As\ given\ in\ table.$$

- Diameter 15 mm And Also Available In 6-90 mm
- Technique Hot Rolled
- Tensile Strength 100-400 Mpa
- Material Mild Steel

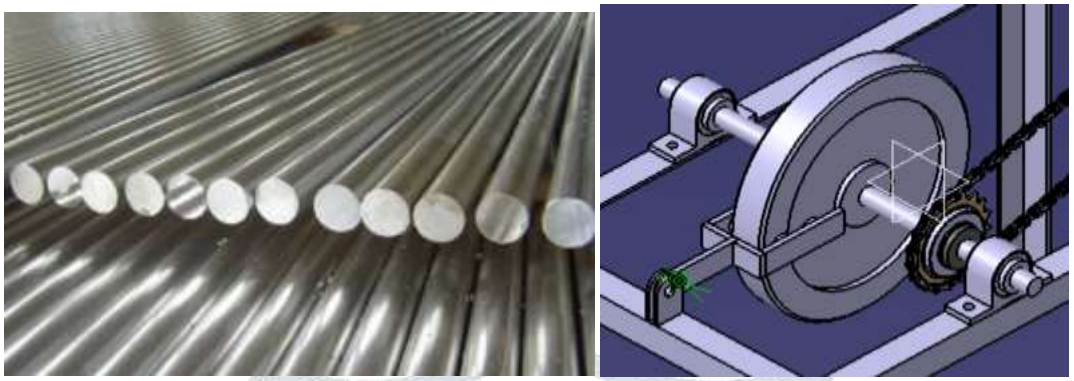


Figure 5.2.1 Shaft a. (Online source). b. Proposed Design of shaft.

5.3 Bearing Selection on shaft

- A bearing is a component of a machine that limits relative motion to only that which is desired and lessens friction between moving elements. The bearing's design may, for instance, permit free rotation around a fixed axis or free linear movement of the moving part. It may also serve to prohibit motion by managing the vectors of normal forces acting on the moving parts.

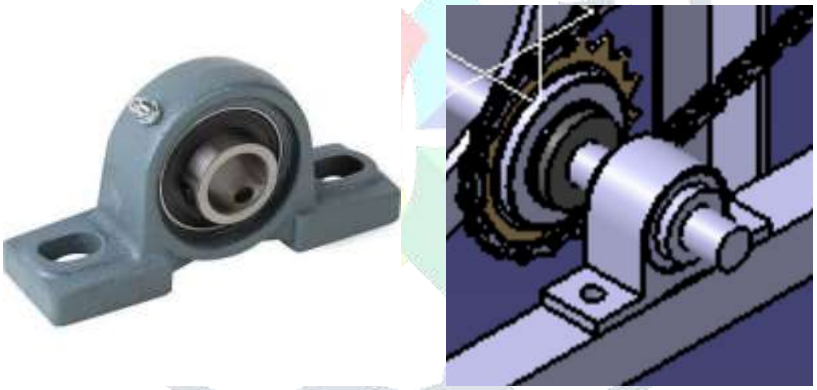
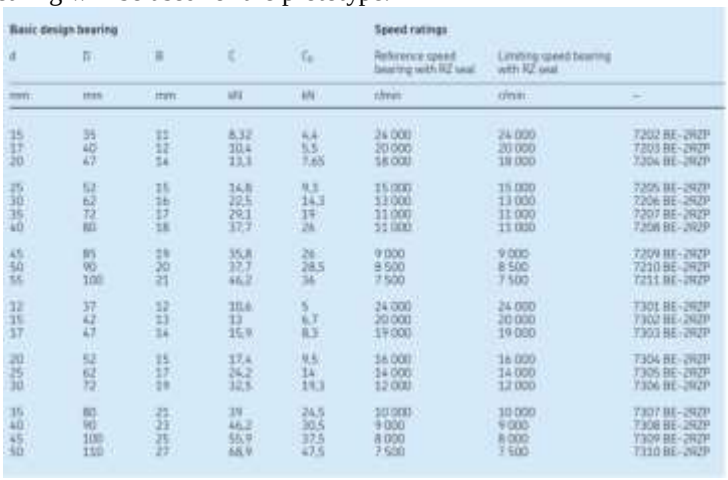


Figure 5.3.1 a. (Online source). b. Proposed Design of shaft Bearing for smooth rolling and less friction purpose.

- An identical bearing will be choosed up on the availability of the shaft size from the market.

Calculated shaft size is	=	Diameter	=	15 mm
	=	length	=	350 mm
	=	Internal diameter of bearing required is 15 mm		

- A Universal type of bearing will be used for the prototype.



Basic design bearing					Speed ratings		
d	D	B	C	C_0	Reference speed bearing with RZ seal	Limiting speed bearing with RZ seal	
mm	mm	mm	kN	kN	r/min	r/min	–
15	35	11	8,32	4,4	24 000	24 000	7202 BE-2RZP
17	40	12	10,4	5,5	20 000	20 000	7203 BE-2RZP
20	47	14	13,3	7,65	18 000	18 000	7204 BE-2RZP
25	52	15	14,8	9,3	15 000	15 000	7205 BE-2RZP
30	62	16	22,5	14,3	13 000	13 000	7206 BE-2RZP
35	72	17	29,1	19	11 000	11 000	7207 BE-2RZP
40	80	18	37,7	26	11 000	11 000	7208 BE-2RZP
45	85	19	35,8	26	9 000	9 000	7209 BE-2RZP
50	90	20	37,7	28,5	8 500	8 500	7210 BE-2RZP
55	100	21	46,2	36	7 500	7 500	7211 BE-2RZP
12	37	12	10,6	5	24 000	24 000	7301 BE-2RZP
15	42	13	13	6,7	20 000	20 000	7302 BE-2RZP
17	47	14	15,9	8,3	19 000	19 000	7303 BE-2RZP
20	52	15	17,4	9,5	16 000	16 000	7304 BE-2RZP
25	62	17	24,2	14	14 000	14 000	7305 BE-2RZP
30	72	19	32,5	19,3	12 000	12 000	7306 BE-2RZP
35	80	21	39	24,5	10 000	10 000	7307 BE-2RZP
40	90	23	46,2	30,5	9 000	9 000	7308 BE-2RZP
45	100	25	55,9	37,5	8 000	8 000	7309 BE-2RZP
50	110	27	68,9	47,5	7 500	7 500	7310 BE-2RZP

Figure 5.3.2 SKF Standard bearing sizes

5.4 Motor Selection

From Catia Cad Software we have measured the material Weight of the 20 mm aluminum disc as = 2.1 kg as shown in the below figure.

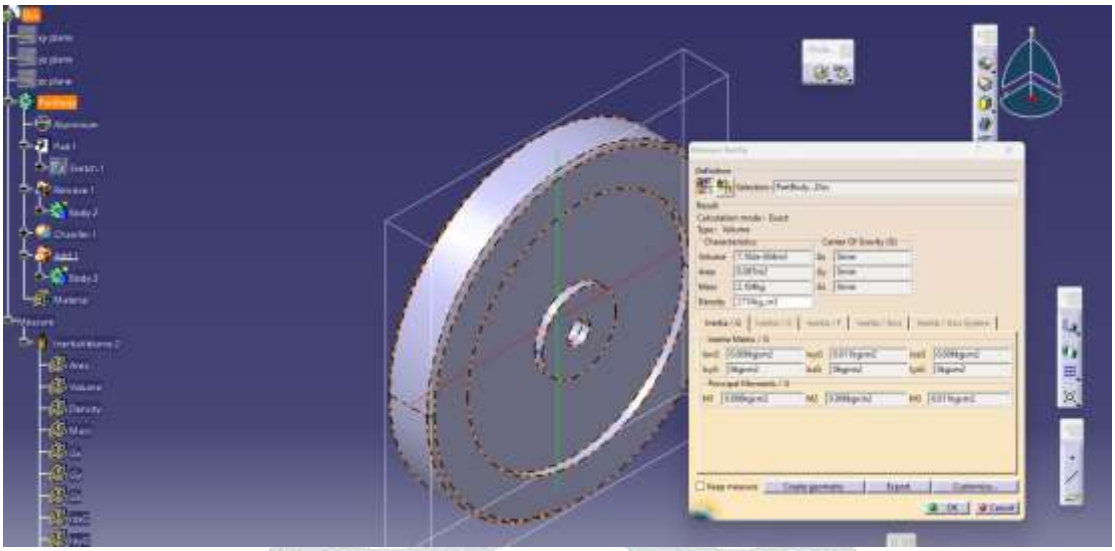


Figure 5.4.1 Aluminum Disc Mass from Catia Cad Software.

T = 1/2. D.W
T = Torque
D = diameter of disc = 200 mm
W = total weight of setup=2.1 *9.81 = 20.606 N
T = 1/2 x 200 x 20.606 = 2060.1 Nmm2
= 2.06 Nm2

Torque required for motor

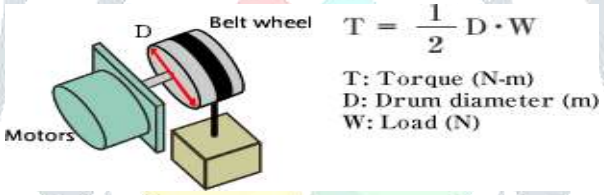


Figure 5.4.2 online Source

5.5 Battery

1. Voltage 6 V
2. Current 4.5 Ah

- This system is using 24 V of motor so the battery will be connected in series connection so that it will make 24 volts.

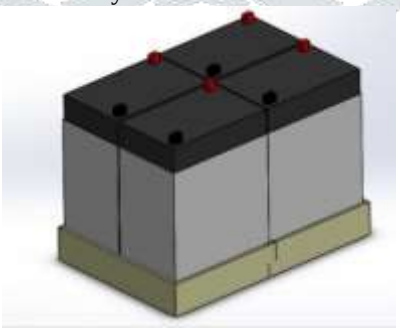


Figure 5.5.1 Cad Model of a battery

5.6 Designs of Proposed Systems

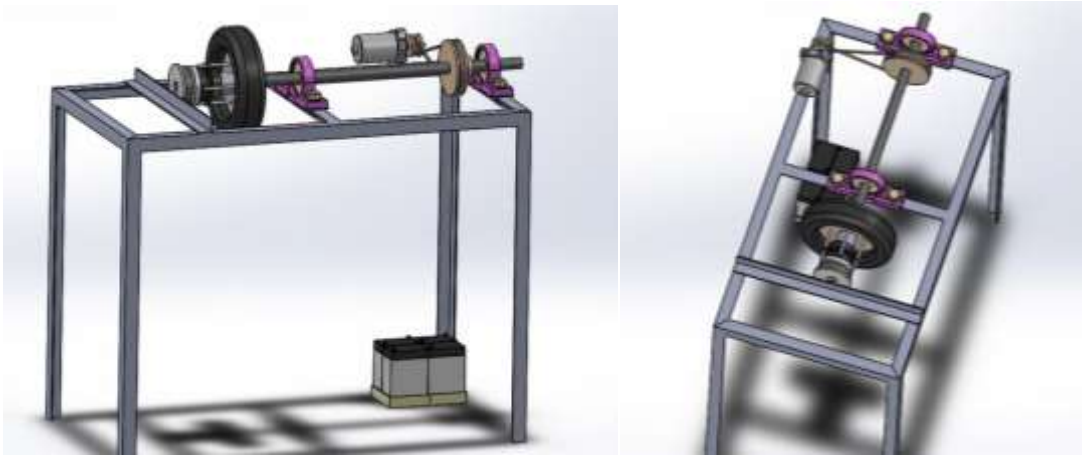


Figure 5.6.1 a & b ISO views of the CAD Models

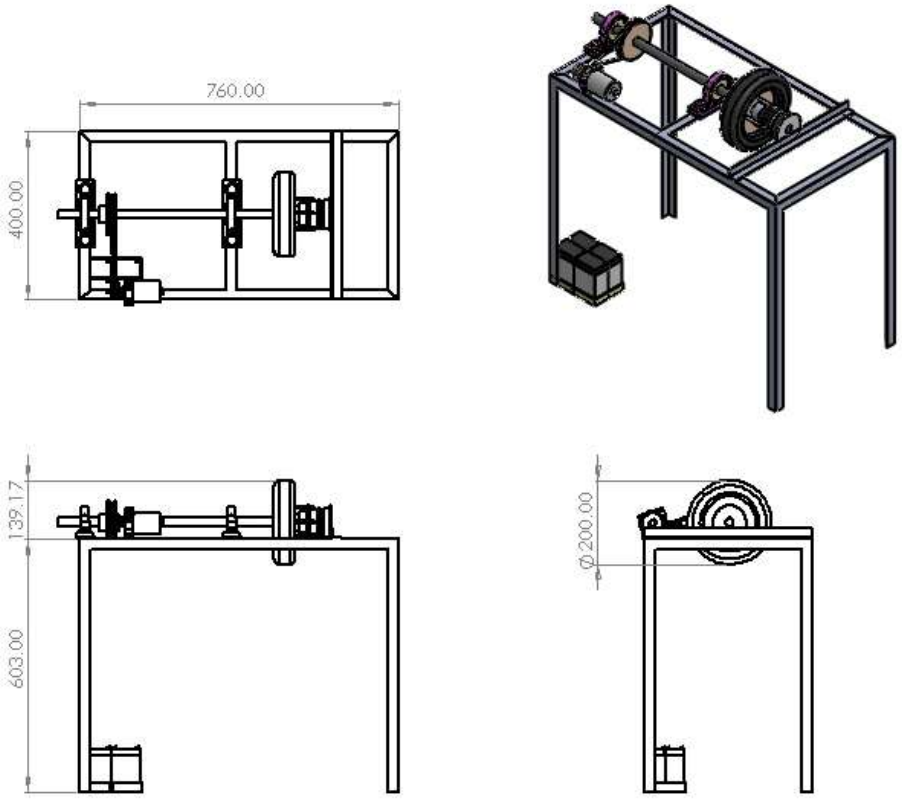


Figure 5.6.2 Draft vie of all section's

5.7 Working Methodology of The System

When the power supply is given the motor, the pulley is driven by the belt. Now the pulley is continuously rotated. As the steel plate is connected along with pulley it is rotated Infront of the electromagnet. When the braking is required the control switch is turned on. So, the current or voltage is applied on the electromagnet. A magnetic field is created by an energizing coil by the application of voltage or current. This coil develops magnetic lines of flux between the metal disc thus attracting the armature to the face of the metal disc. When the current or voltage is removed from the brake (electromagnet) the metal disc is free to rotate. Here springs are used as medium to hold the armature winding of the electromagnet away from the disc. Rotating motion in wheels is achieved by switching controls of the supply to the coil. Slippage occurs only during deceleration only when the brake is engaged, there should not be slippage once the brake comes to a full halt.

VI. CONCLUSION

The electromagnetic brake system can significantly improve braking efficiency while reducing brake friction wear. Bringing this technology to market has the potential to generate additional revenue for automakers and expand their customer base. This reaffirms the company's commitment to safety and quality. By manufacturing this brake, we can sell it at a much lower price than an outsourced system and still make a profit.

The design system is working as per the idea we thought this type of brakes can reduce the noise of brakes when we apply. Also increases span life for its contactless brake applications. Fast and secure, even these types of brakes can be automated in future using Sensor modules of obstacles and camera modules with the help of micro-controller.

6.1 Cost Estimation

SR NO	PART NAME	MAT	QTY	COST
1.	ANGLES	MILD STEEL	10 KG	1100
2.	BELT	STD	1 NO	1200
3.	PULLEY	STD	2 SET	1500
4.	FREE WHEEL	STD	1 NO	1100
5.	MAGNET	STD	1 NO	400
6.	SHAFT	MILD STEEL	5 KG	550
7.	WHEEL	NYLON	5 NOS	5000
8.	SPRAY PAINT	STD	3 NO	1050
9.	NUT BOLTS	STD	1 KG	120
10.	PEDESTIAL BEARING	STD	2 NO	500
11.	PMDC MOTOR	STD	1 NO	1200
12.	BATTERY 12V	LEAD ACID	1 NOS	1300
13.	BATTERY 6V	LEAD ACID	2 NOS	650
14.	CHARGER	STD	1 NO	450
15.	WIRES	COPPER	5 M	150
16.	HOLLOW PIPE BUSH	MILD STEEL	5 KG	550
17.	MISCELLINOUS			500
	TOTAL			17320

Figure 6.1.1 Cost Estimation of the project.

VII. ACKNOWLEDGMENT

The preferred spelling of the word “acknowledgment” in America is without an “e” after the “g”Avoidthestiltedexpression, “Oneofus(R.B.G.)thanks...”
Instead,try“R.B.G.thanks”.Putapplicablesponsoracknowledgmentshere;DONOTplacethemonthefirstpageofyourpaperorasafootnote.

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