International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 05 | May 2021 www.irjet.net p-ISSN: 2395-0072

DESIGN AND FABRICATION OF REGENERATIVE BREAKING SYSTEM

G. Jerome Nithin Gladson[1], Suriya B[2], Ashok Kumar[3], A Kalyan[4]

[1]Professor, Dept. of Mechanical Engineering, Saveetha Engineering College, Chennai, Tamil Nadu, India
[2, 3, 4]UG Scholars, Dept. of Mechanical Engineering, Saveetha Engineering College, Chennai, Tamil Nadu, India

---

Abstract – *As in today's world, where there are energy crises and therefore the resources are depleting at a better rate, there's a requirement of specific technology that recovers the energy, which gets usually wasted. So, just in case of automobiles one among these useful technologies is that the regenerative braking system. The special braking mechanism is selectively held in position by a rider- controlled clutch mechanism, to accumulate energy over several braking events. Vehicles driven by electric motors use the motor as a generator when using regenerative braking and its output is supplied to an electrical load. A brake-pad assembly, mounted concentrically with the hub of a ground- engaging wheel, is actuated upon braking to supply frictional engagement between the hub and clutch mechanism, while applying a decelerating torque to the wheel.*

Key Words: Breaking, Energy, Mechanism, Friction

1. INTRODUCTION

In recent years, there is the lack of reliable alternative energy sources, increasing efficiency and reducing exhaust gas emissions has become the focus of the modern automotive research. Commercial vehicles such as refuse trucks and delivery vehicles lose a tremendous amount of kinetic energy during frequent braking and constant drive at low speeds on designated city routes, which results in higher fuel consumption and Green House Emission Gas (GHG) emission than other on-road vehicles. Numerous attempts have been made to improve type of vehicles.

1.1 Working Principle:

Regenerative braking is a braking method that utilizes the mechanical energy from the motor by converting kinetic energy into electrical energy and fed back into the battery source. Theoretically, the regenerative braking system can convert a good fraction of its kinetic energy to charge up the battery, using the same principle as an alternator.

1.2 Motivation of the work:

The current world is shifting from fuels to electric power. So it is essential to generate such electric power which is renewable and more efficient.

1.3 Aim of the Work:

Aim of the work is to obtain power out of regenerative breaking system with maximum efficiency.

1.4 Objectives of the Work:

The main objectives of the work are as follows

- Increasing the efficiency of vertical axis breaking system
- Minimizing the cost of breaking system
- Easy setup and portable

2. LITERATURE REVIEW

1. Sayed Nashit, Sufiyan Adhikari, Shaikh Farhan, Srivastava Avinash and Amruta Gambhire, 'Design, Fabrication and Testing of Regenerative Braking Test Rig for BLDC Motor', 2016, 1881-84. In this paper [17] a test bench for testing of regenerative braking capability of a Brushless DC Motor is design and then fabricated.

The project creates awareness to engineers towards energy efficiency and energy conservation. It concludes that the regenerative braking systems are more efficient at higher speed and it cannot be used as the only brakes in a vehicle. The definite use of this technology described as in the project in the future automobiles can help us to a certain level to sustainable and bright future of energy efficient world as a part of power that is lost can be regained by using the regenerative braking system.

2. Khushboo Rahim, and Mohd. Tanveer, 'Regenerative Braking System: Review Paper', International Journal on Recent and Innovation Trends in Computing and Communication, 5.5 (2018), 736-39. In this paper [18] the advantages of regenerative braking system over conventional braking system has been mentioned. Regenerative braking systems can work at the high temperature ranges and are highly efficient when compared to the conventional brakes. They are more effective at higher momentum.

The more frequently a vehicle stops, the more it can benefit from this braking system. Large and heavy vehicles that movies at high speeds builds up lots of kinetic energy, so they conserve energy more efficiently. It has broad scope for further advancements and the energy conservation.

3. Tushar L. Patil, Rohit S. Yadav, Abhishek D. are, Mahesh Saggam, Ankul Pratap, 'Performance Improvement of

Regenerative braking system', International Journal of Scientific & Engineering Research Volume 9, Issue 5, (2018). 2229-5518

In this paper [19] the techniques to increase the efficiency of the regenerative braking system is mentioned. The technique mentioned was to reduce the weight of the automobile which increase performance, using super capacitor also improves the conversion rate of energy in regenerative braking system, making the automobile compact also tends to increase the efficiency of the system.

4. C. Jagadeesh Vikram, D. Mohan Kumar, Dr. P. Naveen Chandra, 'Fabrication of regenerative Braking System', International Journal of Pure and Applied Mathematics Volume 119, (2018). 9973-9982.

In this paper [20] the Fabrication process on the Regenerative Braking System had been implemented as per the prescribed measures has been taken and the future enhancements should be processed on basis of the need of the study. The Implementation of the regenerative braking system be quite essential in automotive transportation with maximized performance in braking.

5. A. Eswaran, S Ajith, V Karthikeyan, P Kavin, S Loganandh, 'Design and Fabrication of Regenerative Braking System', International Journal of Advance Research and Innovative Ideas in Education-Vol-4 Issue-3 (2018). 2395-4396,

In this paper [21] the regenerative braking system used in the vehicles satisfies the purpose of saving a part of the energy lost during braking. Also, it can be operated at high temperature range and are efficient as compared to conventional braking system. Regenerative braking systems require further research to develop a better system that captures more energy and stops faster. All vehicles in motion can benefit from these systems by recapturing energy that would have been lost during braking process. The use of more efficient systems could lead to huge savings in the economy of any country.

6. Ketan Warake, Dr. S. R. Bhahulikar, Dr. N. V. Satpute, 'Design & Development of Regenerative Braking System at Rear Axle', International Journal of Advanced Mechanical Engineering. Volume 8, Number 2 (2018), 2250-3234

In this paper [22] the regenerative braking system used in the vehicles satisfies the purpose of saving a part of the energy lost during braking. The regenerative braking system is designed to partially recover the battery charge wasted in braking of the vehicle. The energy is converted into heat by friction brake which is dissipated to the environment.

This Energy is utilized to rotate the rotor of generator converting mechanical energy of wheels into useful charge of battery. The regenerative braking system cannot be used as main braking system of vehicle as it cannot bring the vehicle to rest. Experimentation shows that minimum 11% battery energy can be recovered using the regenerative braking system which would otherwise be wasted to heat in friction brakes. Hence the distance travelled between two successive charging requirements can be increase to 10 to 15 % using this regenerative braking, when installed in actual vehicle.

3. DESIGN CALCULATION:

(i) Bending stress:

$\sigma b = 32Mb/\pi d^3$

M_b = Bending moment = W l/4

Whereas, W = 20 = Load acting

l = 600mm = length of shaft = 20 x 600/4 = 3000N

$\sigma_b = 32*3000/\pi*(20)^3 = 3.821$ K Pa

(ii) Shear stress:

$\sigma = 16T/\pi (d)^3$

Whereas,

Motor torque T = 10kgcm = $10*10^{-1}$ = 0.1Kgm

$=16*0.1/\pi*(20)^3=6.36*10^{-5}$ M Pa

4. FABRICATION MATERIALS:

4.1 Square Bar

These were used in order to build a frame. The Solid bar was of mild steel and was welded into a square frame. Square bars, also known as square steel, squares and square metal bar are a multipurpose steel section mainly used for manufacturing and repairs. General purpose square bars are part of our light and re-rolled section, making it suitable for everyday commercial projects. If you are look for great quality Stainless Steel products then you have come to the right place. We have a variety of grades, sizes and finishes to suit all your requirements whether you are a commercial business or domestic customer. Manifold Pipe Solution Inc. are the No.1 provider of Square Bar products, in Grades 304, 316 and 303, providing a cutting service with a quick turnaround and 1st class polishing service.

4.2 Solid Shaft

Solid shaft used was also of mild steel and were used in order to make the base for the wheel and the brake spindle. The wheel was fitted on the shaft. One of the shafts was connected to the electric motor with the help of pulley and pulley rope. Once the motor starts the motion is transferred from the motor to the pulley and from the pulley to the shaft which rotates the wheel.

4.3 Plummer block

Plummer block is a device with an anti-friction bearing in it, which helps any solid shaft to have rotational movement while holding the outer ring in stationary position. The Plummer block used in the project is of inner diameter 12 mm. The solid shaft is inserted in the bearing which is used for rotational movement in the shaft.

4.4 Bicycle Wheel

The Bicycle wheel used here is a representation of the wheel of automobile or vehicle. It is used in order to show how the movements takes place and brakes are applies to a normal vehicle. The Bicycle wheel is rotated using the pulley and motor connected with the belt.

4.5 Brake Wheel

The brake wheel is used to stop the movement of the shaft. The brake wheel is connected on the shaft and has internal dia. of 12mm.The Brake wheel is made of Polyvinyl Chloride (PVC).

4.6 Brake Spindle

The brake spindle contains a small gear mounted in the tip of the motor. The gear on the brake spindle meshes with another gear on the brake wheel gear and then slows down the movement of the shaft.

4.7 DC motor

A DC motor is any of a class of rotary electrical motors that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current in part of the motor.

4.8 LED

These are used in order to show the power generated from the regenerative brakes.

4.9 Electric Wires

The inner wire is made of with copper and it is insulated. They are used in order to transfer the power from the motor to the LEDs.

4.10 Brushed D.C Motor

This motor is used as Dynamo. The motor tip is connected to the gear and when the gear meshes with the brake wheel gear, the motor spindle rotates. The rotating spindle has kinetic energy and due electro-magnetic force the kinetic energy is converted into electrical energy. The motor has the capacity of 12v.

5. EQUIPMENTS USED IN FABRICATION:

5.1 Drilling

Drilling is a metal removal process that uses a drill bit to cut or enlarge a hole of circular cross- section in solid materials. The drill bit is a rotary cutting tool, often multipoint. The bit is pressed against the work piece and rotated at rates from hundreds to thousands of revolutions per minute. This forces the cutting edge against the work piece, cutting off chips from what will become the hole being drilled.

Fig 5.1 Drilling Equipment

5.2 Metal-Cutting:

Metal cutting is a process by which the excess metal is removed by the work piece in the form of chips. There process we used in order to get the work piece of the required dimension was by using a hacksaw blade. The square bar was cut in angle at 45° to join the bar and create a frame which is later welded together to form the base of the model.

6. EXPERIMENTAL PROCEDURE:

- First the square bar is cut into an angle of 45 degree and then welded together in order to form a square frame.
- The square bar is welded at each corner to form a table like structure.
- The flat mild steel plate is drilled and welded in the square bar to hold the solid shaft for brake spindle.
- The Plummer block is fitted over the flat plate welded on the square frame.
- Solid shaft is inserted in the Plummer block upon which the bicycle wheel and brake wheel and pulley are fitted. On the Frame the motor is welded.

- The power of the motor is transmitted to the Bicycle wheel by the joining the pulley and motor with a belt.
- The brake wheel is fixed at the tip of the Geared D.C motor which is fixed upon the brake spindle.
- The L.E.Ds is fixed on the square frame.
- The output of the Geared D.C motor is connected to L.E.Ds through copper wire.
- The small wheels are placed on the legs to give movements to the Assembly.
- The Entire Assembly is colored with Red and black Paint to protect from rust.

6.1 Precautions used during Fabrication:

- The Apron is worn at every process during Fabrication.
- Face shield and welding gloves are used during the welding process.
- Proper coolant is supplied during the Drilling process.
- Gloves are used to project hands during the Grinding process.
- The materials were handled very carefully during the Fabrication.

7. DEVELOPMENT OF SET UP:

S no	Part Name	Specifications
1	DC Motor	Torque 10Kgcm, Speed 1000rpm
2	Shaft	Hollow, 600 mm
3	Digital Meter	0~99V & 0~99A Display view
4	Dynamic	Max output 0-12V
5	Bearing	20Diameter
6	Alloys	Mild steels (ISI Grade)

7.1 Components Required:

The following components are required to fabricate the Regenerative breaking system.

S.NO	Component name
1.	Dynamic
2.	Shaft
3.	Digital Meter
4.	DC Motor
5.	Wires
6.	Switch keys

7.2 Development Procedure

1. Planning:

Initially reviewing and studying the existing research papers and physical model available concisely and then to focus on the planning of the further.

2. Designing:

With the collection of initial data and values, calculation is carried and respective designing of the model is processed.

3. Material selection:

It is crucial to select the material through which only the fabrication is possible. Separate material for each separate parts are decided and finalized.

8. OBSERVATION AND RESULT:

8.1 To find output of the project:

We connected the dynamic with an digital meter to obtain the resultant output. With the moderate speed of DC Motor, the revolution speed was found to be low though by using digital meter we obtained the following values and calculated the power output.

Fig 8.1 Fabricated Models

8.2 Result:

Finally, we had our output value for power calculations. We realized that due to various losses like friction loss, weight loss and less speed caused, reduction to revolution and hence this led to less output values. But Overcoming these we had max output of this mini project.

Output voltage = 5.4 volts Current = 0.45 amps

Power = volt x current = 5.4 x 0.45 amps Power = 2.43 watts

By this observation we can light a Small LED light and also we can store this for duration of time and use it further.

9. CONCLUSION:

Hence regenerative braking system used in the vehicles satisfies the purpose of saving a part of the energy lost during braking. The regenerative braking system is designed

to partially recover the battery charge wasted in braking of the vehicle. The energy is converted into heat by friction brakes which are dissipated to the environment. This Energy is utilized to rotate the rotor of generator converting mechanical energy of wheels into useful charge of battery. The regenerative braking system cannot be used as main braking system of vehicle as it cannot bring the vehicle to rest.

9.1 Future Work:

Future developments, however, such as ultra-capacitors, flywheels and hydraulic systems could have much higher power capacities, which could open up the possibility to rely more heavily on the regenerative braking system, even for high speed, high stops and the opportunity to down size or even eliminate the friction-braking system.

ACKNOWLEDGEMENT

We mention our special thanks to our guide Mr. G. Jerome Nithin Gladson, M.E., for his guidance, support and faith in us throughout this endeavor.

We also would like to express our gratitude to our parents and friends who have been very patient and supportive to us during the entire time we spent on this project. We also thank everyone who has been directly and indirectly involved for successful completion of our project.

REFERENCES

[1] A.Rufer and P.Barrade, “A supercapacitor-based energy storage system for elevators with soft commutated interface”, The 36 IEEE Industry Applications Conference vol.2, pp.1413-1418, 2001

P. J.Grbovic, P.Delarue, P.Le Moigne, and P Bartholomeus, “A bidirectional three-level dc-dc converter for the ultra-capacitor applications”, IEEE Trans. Ind. Electron., vol. 57, no. 10, pp. 415– 3430, Oct. 2010

[2] A.Sathyan, N.Milivojevic, Y.-J. Lee, M. Krishnamurthy and A.Emadi, “An FPGA-based novel digital PWM control scheme for BLDC motor drives”, IEEE Trans. Ind. Electron., vol. 56, no. 8, pp. 3040–3049, Aug. 2009

[3] Ming-Ji Yang, H.-L. J.-Y.-K. “A Cost-Effective Method of Electric Brake With Energy Regeneration for Electric Vehicles”, IEEE TRANSACTIONS ON INDUSTRIALELECTRONICS, VOL. 56, 2203-2212, june 2009.

[4] H. Wu, S. Cheng and S. Cui, "A controller of brushless DC motor for electric vehicle", IEEE Trans, vol. 40, no. I, pp. 509-513, January 2005.