

# **DESIGN AND FABRICATION OF REGENERATIVE BRAKING SYSTEM FOR DRUM BRAKES**

Submitted in partial fulfilment of the requirements for the completion of  
INTERDISCIPLINARY PROJECT

By

**G.S. PRAVEEN KUMAR (40150704)**

**R. KARTHICK KUMARAN (40860702)**

**R. ROSARIO (40150039)**

**U. EZHILAN (40150716)**



**DEPARTMENT OF AUTOMOBILE ENGINEERING**

**SCHOOL OF MECHANICAL ENGINEERING**

**SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY**

**(DEEMED TO BE UNIVERSITY)**

**Accredited with grade “A” by NAAC**

**JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI – 600119**

**APRIL 2023**



## DEPARTMENT OF AUTOMOBILE ENGINEERING

### **BONA FIDE CERTIFICATE**

This is to certify that this Project Report is the bonafide work of **G.S. PRAVEEN KUMAR (40150704), R. KARTHICK KUMARAN (40860702), R. ROSARIO (40150039), U. EZHILAN (40150716)** who carried out the Interdisciplinary Project entitled **DESIGN AND FABRICATION OF REGENERATIVE BRAKING SYSTEM FOR DRUM BRAKES** under our supervision from February 2023 to April 2023.

**Internal Guide**

**Mr. AROCKIA SUTHAN, ME., PhD.,**

**External Guide**

**Dr. G. ARUNKUMAR, ME., PhD.,**

**Head of the Department**

**Dr. V.K. BUPESH RAJA, ME., PhD.,**

Submitted for Viva voce Examination held on 28.04.2023

**Internal Examiner**

**External Examiner**

## **DECLARATION**

I **R. KARTHICK KUMARAN (40860702)**, hereby declare that the Project Report entitled "**DESIGN AND FABRICATION OF REGENERATIVE BRAKING SYSTEM FOR DRUM BRAKES**" done by me under the guidance of **Mr. AROCKIA SUTHAN, ME., PhD.,** and **Dr. G. ARUNKUMAR, ME., PhD.,** is submitted in partial fulfilment of the requirements for the completion of Interdisciplinary Project.



**DATE:** 01.04.2023

**SIGNATURE OF THE CANDIDATE**

**PLACE:** CHENNAI

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## **SYNOPSIS**

During the engineering study, the students are made to enrich their theoretical and practical knowledge as well.

But after graduation, they are not given a separate chance in their working industries to bring out their own ideas and creative thinking.

Keeping this in consideration, the students are encouraged to do the project work to express their new and innovative ideas under the guidance of experienced lecturers.

Innovations come along with new products including cars and motorcycles and are necessary in terms of advancement and consumer satisfaction.

In today's world innovations grow like mushrooms with almost every brand offering you sophisticated technology which you may not understand but it is important. If one must make a choice between luxury and running cost, many of the customers will be inclined towards the running cost on the fuel consumption of the vehicle and to suppress it, numerous innovations and inventions have been done.

## **ABSTRACT**

Regenerative braking is a mechanism found on most hybrid electric vehicles. It captures the kinetic energy from braking and converts it into the electrical power that charges the vehicle's high voltage battery. In a conventional braking system, a car slows down due to friction between the brake pads and rotors. But this system is highly inefficient when it comes to conserving energy. Nearly all of the kinetic energy propelling your car forward is lost in heat when you apply the brakes. That is a lot of wasted energy.

Regenerative braking solves this problem by recapturing upwards of 70% of the kinetic energy that would otherwise be lost during braking. The amount of energy recovered depends on your car model and driving behavior. The objective of our project is to study this new type of braking system that can recollect much of the car's kinetic energy and convert it into electrical energy or mechanical energy. Hence, the project enables the student to improve their skills and to understand the working knowledge of REGENERATIVE BRAKING SYSTEM.

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## **CHAPTER - 1**

### **INTRODUCTION**

A brake is a mechanical device that inhibits motion by absorbing energy from a moving system. It is used for slowing or stopping a moving vehicle, wheel, axle, or to prevent its motion. Most often accomplished by means of friction. Regenerative braking is an energy recovery mechanism that slows the object or vehicle by converting its kinetic energy into a form that can be either used immediately or stored until needed.

In this project we are applying this concept to one wheel which is rotating. Its mechanical rotary energy is converted into electrical energy. This electrical energy can be stored and utilized in critical situations or to run the internal components present in the vehicle.

Regenerative braking is one of the emerging technologies of the automotive industry which can prove to be very beneficial. Using a regenerative braking system in a vehicle not only results in the recovery of the energy but it also increases the efficiency of the vehicle and saves energy, which is stored in the auxiliary battery.

Regenerative braking is not industry specific, but can be difficult to implement cost effectively. In most applications heavy loads must be stopped and started frequently. The action of starting and stopping is controlled to limit power required. In this project we decided to work on all the above factors of the regenerative braking system and we are attempting to sort it out effectively.

## **CHAPTER – 2**

### **LITERATURE SURVEY**

A test seat for testing of regenerative slowing down capacity of a Brushless DC motor is configured and afterward created (1). The task draws attention to engineers towards energy effectiveness and energy protection. It reasons that the regenerative slowing mechanisms are more productive at higher speed and it can't be utilized as the main brakes in a vehicle. The unmistakable utilization of this innovation depicted as in the task later on cars can help us to a specific level to reasonable and brilliant eventual fate of the energy effective world as a piece of force that is lost can be recaptured by utilizing the regenerative stopping mechanism.

The methods to build the effectiveness of the regenerative stopping mechanism are referenced (2). The method referenced was to lessen the heaviness of the car which increment execution, utilizing super capacitor additionally further develops the transformation pace of energy in regenerative stopping mechanism, making the auto minimal likewise will in general expand the proficiency of the framework.

The Manufacture cycle on the Regenerative Stopping mechanism had been executed according to the recommended measures and the future improvements ought to be handled on premise of the need of the review (3). The Execution of the regenerative stopping mechanism is very fundamental in car transportation with augmented execution slowing down.

The regenerative slowing mechanism utilized in the vehicles fulfills the reason for saving a piece of the energy lost during slowing down (4).

Additionally, it tends to be worked at a high temperature range and is productive when contrasted with regular slowing mechanisms.

Regenerative slowing mechanisms require further exploration to foster a superior framework that catches more energy and stops quicker. All vehicles moving can profit from these frameworks by recovering energy that would have been lost during the slowing down process. The utilization of additional effective frameworks could prompt colossal reserve funds in the economy of any country.

The regenerative slowing mechanism utilized in the vehicles fulfills the motivation behind saving a piece of the energy lost during slowing down (5).

The regenerative slowing mechanism is intended to some degree recuperate the battery charge squandered in slowing down of the vehicle.

The energy is changed over into heat by grinding brakes which are disseminated to the climate. This Energy is used to pivot the rotor of the generator changing over mechanical energy of wheels into helpful charge of battery.

The regenerative stopping mechanism can't be utilized as the primary slowing mechanism of a vehicle as it can't carry the vehicle to rest.

Trial and error demonstrates the way that base 11% battery energy can be recuperated utilizing the regenerative stopping mechanism which would somehow or another be squandered to warm in grinding brakes. Consequently the distance between two progressive charging

necessities can be incremented to 10 to 15 % utilizing this regenerative slowing down, when introduced in genuine vehicles.

In this paper (6) it is referenced that Regenerative slowing down can set aside 25% to 28% of waste energy. The frameworks have been upgraded with cutting edge power electronic parts like ultra-capacitors, DC converters (Buck-Lift) and flywheels.

Ultra-capacitors, which assist with working on the transient condition of the vehicle during fire up, give a smoother charging normal for the battery and work on the general execution of the electric vehicle framework.

Buck-support converters assist with keeping up with power the executives in regenerative slowing mechanisms, for example, helping speed increase.

At long last, flywheels are utilized to further develop the power recuperation process through car wheels.

We have gained the proposal and end from the past scientist and afterward we have used it in our examination. We have likewise changed

the parts and strategies as the specialist recommended to make the trial more pragmatic and effective.

The upsides of regenerative stopping mechanisms over traditional stopping mechanisms has been referenced (7).

Regenerative slowing mechanisms can work at the high temperature and are profoundly effective when contrasted with the ordinary brakes.

They are more compelling at higher force. The more of the time a vehicle stops, the more it can profit from this slowing mechanism.

Huge and weighty vehicles that motion pictures at high rates develop heaps of dynamic energy, so they preserve energy all the more effectively.

It has expansive extensions for additional headways and energy preservation.

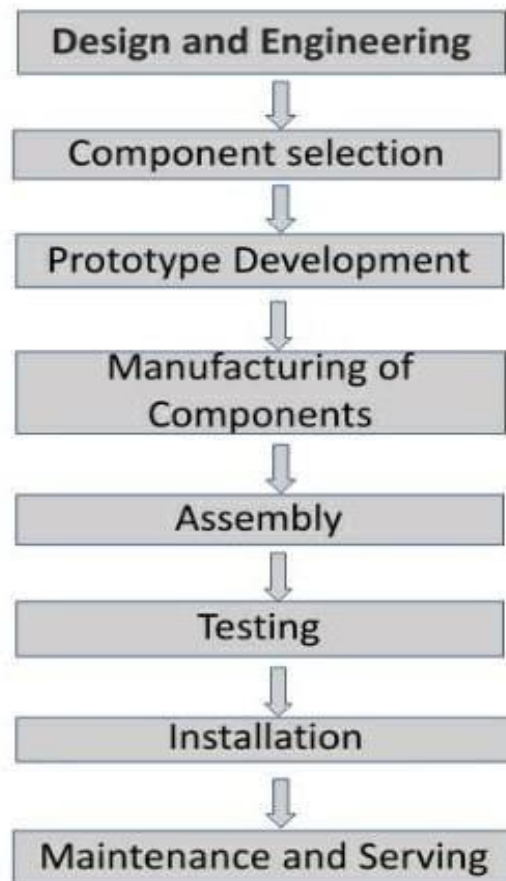
In paper (8) proposed electronic stopping mechanism for EV and HEV coordinates the regenerative slowing down, naturally controlled mechanical slowing down together.

This stopping mechanism can recuperate the greater part of slowing down energy.

Thus, the energy productivity of the vehicle can be essentially gotten to the next level.

In the meantime, the slowing down apparatus can understand wheel antilock capability by controlling the electric engine and additionally the electrically fueled slowing down actuators.

# METHODOLOGY



## **CHAPTER – 3**

### **PROJECT DESCRIPTION**

#### **CHAPTER - 3 (a)**

#### **WORKING PRINCIPLE**

- Hybrid electric vehicles apply battery technology, aerodynamics and other engineering achievements to achieve efficiency in driving. One such feature is the regenerative braking system. Regenerative braking system captures energy that is otherwise lost during braking and then uses this power to help recharge the vehicle's battery.
- This project is a contact type regenerative braking system. In this project a wheel is mounted on a shaft which is supported by the frame.
- A roller is mounted in the shaft which is fixed and rotates along with the shaft revolution. Another roller is placed on a separate shaft that is connected to the 6v dynamo.
- The dynamo is connected to the brake lever which is connected to the brake arm of the brake drum. The lever moves up and down, engaging and

disengaging the brake. The dynamo is connected to a LED light display and also another output wire which is connected to a multimeter which displays the voltage of current produced by the dynamo. This is also used to recharge the 12v battery.

- The battery is connected to a 12v DC motor. The 12v DC motor is connected to the wheel by a chain drive system using two sprockets.
- The driving sprocket is connected to the DC motor and the driven sprocket is connected to the wheel shaft which rotates the wheel. The battery is connected to the DC motor through an switch.
- When the switch or switch is turned on the current from the 12v Battery is sent to the 12v DC motor which rotates the driving sprocket.
- This driving sprocket is connected to the driven sprocket through a chain drive mechanism. This rotates the driven sprocket that is welded on the main shaft. When the sprocket rotates the main shaft where the wheel is mounted is rotated and it reaches a certain speed.

- Then the brakes are applied by pressing the lever which applies the brake as well as it brings the roller that is connected to dynamo towards the roller on the main shaft.
- This brings the main shaft roller and the dynamo roller to come in contact with each other. This rotates the roller connected to the dynamo and thus rotating the 12v dynamo as well. The dynamo produces an output voltage of 6v which is used to indicate use of LED lights.
- The output current produced is also sent to an output wire which is connected to a multimeter that shows the output voltage through a seven-segment display on the multimeter.
- This current produced can also be used to charge the battery. When brakes are applied both the regenerative braking and the regular braking system is used which acts as a failsafe system if one of the braking systems fails. When the brakes are released, the regenerative braking stops and regular running condition is achieved. This is the working principle of the contact type regenerative braking system.

## **CHAPTER - 3 (b)**

### **COMPONENTS**

#### **DC MOTOR:**

A direct current (DC) motor is a type of electric machine that converts electrical energy into mechanical energy. DC motors take electrical power through direct current, and convert this energy into mechanical rotation. It has a capacity of 12v.

#### **SPROCKET:**

Totally two sprockets are used in this system of diameter 30mm. One is connected to the DC motor and another sprocket is connected to the wheel. Both the sprockets are linked by the chain.

#### **BATTERY:**

The 12V battery is used as a power source to run the DC motor.

#### **WHEEL AND TYRE:**

One of the Two wheeler's wheels and tires is used in this regenerative braking system.

**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.

**IRON FRAME (WELD):**

Used to mount the entire system. The frame we used for this fabrication was made up of iron.

**GENERATOR MOTOR:**

This motor is used as the dynamo. The motor shaft is connected to another gear and when the gears mesh, the motor spindle rotates. The rotating spindle has kinetic energy and due to electro-magnetic force, the kinetic energy is converted into electrical energy. The DC generator has the capacity of 12v.

**MULTIMETER:**

A multimeter is a test device used to quantify at least two electrical qualities, basically: voltage (volts), flow (amps) and obstruction (ohms). It is a standard symptomatic device for specialists in the electrical/electronic businesses.

**GEARS:**

One of the brake wheels (gears) is connected to the main motor. It is in continuous motion along with the wheel of the vehicle. It has an internal diameter of 12 mm and is made of Polyvinyl Chloride (PVC).

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

**LED LIGHT:**

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

**CONNECTING WIRES:**

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

**SWITCH:**

These are an alternative to fuses and are used to protect circuits from excess current.

## CHAPTER - 3 (c)

### PARTS LIST

| SI NO | ITEM NAME        | QTY IN NOs |
|-------|------------------|------------|
| 1     | DC MOTOR (12V)   | 1          |
| 2     | 12V BATTERY      | 1          |
| 3     | WHEEL AND TYRE   | 1          |
| 4     | BRAKE SPINDLE    | 1          |
| 5     | FRAME ROD (iron) | 9          |
| 6     | GENERATOR MOTOR  | 1          |
| 7     | MULTIMETER       | 1          |
| 8     | GEARS            | 2          |
| 9     | SPROCKETS        | 2          |
| 10    | CHAIN            | 1          |
| 11    | LED LIGHT        | 1          |
| 12    | MCB SWITCH       | 1          |
| 13    | CONNECTING WIRES | 2 METERS   |

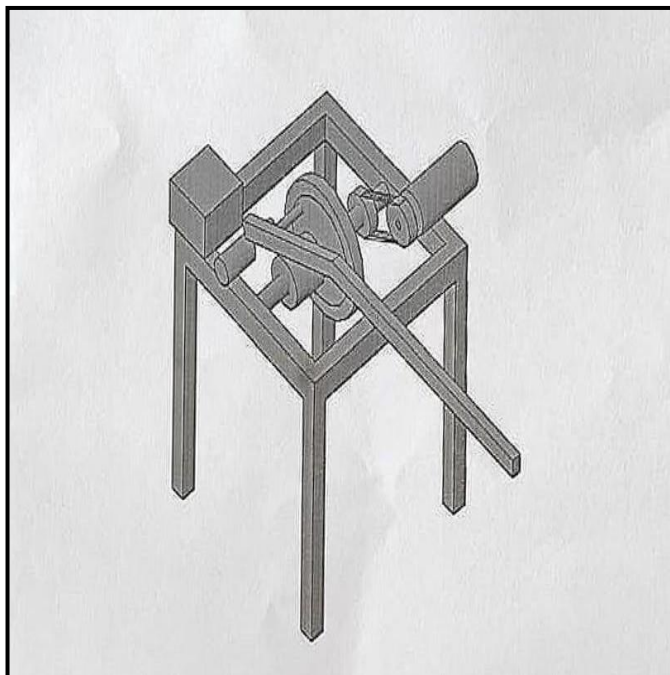
**CHAPTER - 3 (d)**  
**COST ESTIMATION**

| <b>SI NO</b> | <b>ITEM NAME</b> | <b>QTY IN</b> | <b>COST IN</b> |
|--------------|------------------|---------------|----------------|
| 1            | DC MOTOR (12V)   | 1             | 800/-          |
| 2            | 12V BATTERY      | 1             | 1,500/-        |
| 3            | WHEEL AND TYRE   | 1             | 2,000/-        |
| 4            | BRAKE SPINDLE    | 1             | 150/-          |
| 5            | FRAME ROD (iron) | 9             | 3,000/-        |
| 6            | GENERATOR MOTOR  | 1             | 200/-          |
| 7            | MULTIMETER       | 1             | 400/-          |
| 8            | GEARS            | 2             | 250/-          |
| 9            | SPROCKETS        | 2             | 150/-          |
| 10           | CHAIN            | 1             | 100/-          |
| 11           | LED LIGHT        | 1             | 30/-           |
| 12           | MCB SWITCH       | 1             | 400/-          |
| 13           | CONNECTING WIRES | 2 METERS      | 200/-          |
| 14           | LABOUR           | -             | 2,000/-        |
| 15           | TOTAL            | -             | 11,180/-       |

## **CHAPTER - 3 (e)**

### **PROJECT LAYOUT**

#### **REGENERATIVE BRAKING SYSTEM**



## **CHAPTER - 4**

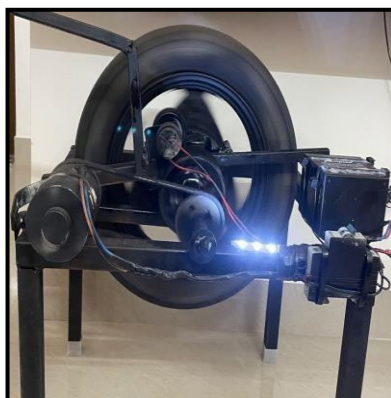
### **RESULT AND DISCUSSION**

#### **4.1 RESULT:**

A model of the regenerative braking system is fabricated. After successful testing, the system is able to stop the vehicle by producing electrical energy in return.



**Fig 4.1: when RBS brake is not applied**



**Fig 4.2: when RBS brake is applied**

## **DISCUSSION:**

With the markets for hybrid, electric and highly efficient, low emission conventionally- powered vehicles set to grow rapidly, the pace of development of regenerative braking systems looks similarly set to increase. The two critical hindrances to the market for battery-electric vehicles (BEVs) are as of now their significant expense (especially of the battery packs) and restricted range. For framework engineers, future difficulties will incorporate lessening costs, expanding vehicle reach and meeting stricter security and discharges guidelines. The slowing down guideline should be applied to cutting edge frameworks that stop the vehicle as well as recuperate lost slowing down energy. In rundown, the examination proposes that current, "original" regenerative slowing mechanisms don't think twice about security. The tests on one such framework, fitted to a cross breed vehicle, raised no wellbeing issues. The essential determinant of how strong the regenerative stopping mechanism may be the power limit of the battery or other energy stockpiling gadget/framework, that is all there is to its capacity to change over the active energy of the vehicle into it put away structure rapidly. Fundamental mechanical designing hypothesis proposes for current frameworks, which can work at very low power levels ( $< 30\text{KW}$ , say), the regenerative slowing down part is probably going to be minuscule,

especially at high rates. Such frameworks in this way need a significant extra wellspring of slowing down force for medium-high deceleration prevents from such velocities, for example a regular contact slowing mechanism.

## **CHAPTER - 5**

### **ADVANTAGES**

#### **Energy conservation:**

The wheel retains energy while slowing down by means of a grip structure dialing the vehicle back and accelerating the wheel. To speed up, another grip structure associates the flywheel to the drive train, accelerating the vehicle and dialing back the flywheel. Energy is in this way monitored as opposed to squandered as intensity and light which regularly occurs in the contemporary shoe/circle framework.

#### **Battery economy:**

The amount of electricity consumed can be decisively diminished with this kind of slowing mechanism. The energy effectiveness of an ordinary vehicle is just around 20%, with the leftover 80% of its energy being changed over completely to warm through grinding. The marvelous thing about regenerative slowing down is that it could have the option to catch however much 50% of that squandered energy and set it back to work. This could decrease electrical energy utilization by 10 to 25%.

**Recharging the battery:**

When the energy is caught by the regenerative brakes, the energy is utilized to re-energize the batteries of the vehicle. Since this energy would ordinarily be lost, it permits every vehicle to encounter a delayed charge while driving.

**Wear reduction:**

In regenerative slowing down, when the engine isn't getting power from the battery pack, it opposes the turning of the wheels, catching a portion of the energy of movement as though it were a generator and returning that energy to the battery pack. Since an electric drive train is important for this setup, the more noteworthy effectiveness given to the slowing down considers a diminished degree of wear on the brakes of the vehicle. With standard contact brakes, it is basically impossible to achieve this advantage.

**Reduced brake costs:**

Cutting down the substitution brake linings cost, the expense of work for establishment, and machine free time.

## **CHAPTER - 6**

### **6. APPLICATIONS**

#### **Hybrid and Electric Cars:**

Present day hybrid and electric vehicles both use an electric motor to drive the vehicle which makes applying regenerative slowing down exceptionally basic and effective.

#### **Railways:**

As regenerative brakes preserve a great deal of energy, they are material in rail routes trains. Jaipur metro framework utilizes the regenerative stopping mechanism and sets aside 35% of electric energy.

#### **Industrial applications:**

Can be utilized in businesses that utilize transport layout to move material starting with one workstation then onto the next and stop at a specific distance after an endorsed span.

#### **Other applications:**

Regenerative braking systems are used in electric elevators, crane lifting motors and kinetic energy recovery mechanisms.

## **7. PRECAUTIONS AND RECOMMENDATIONS**

### **PRECAUTIONS:**

1. The Apron is worn at every process during Fabrication.
2. Gloves are used to protect one's hands during drilling and grinding.
3. All the connections must be soldered and well insulated.

### **RECOMMENDATIONS:**

As this task is totally founded on the exploratory test rig and in the event that this layout is applied in the ebb and flow working vehicles there might be a few issues which might cause awkwardness for drivers. As regenerative slowing mechanisms don't slow down at high velocity so this layout ought to be carried out with different types of Slowing mechanism like Stopping automation (ABS). Executing this framework in the ongoing working vehicle will expand the mass of the vehicle and consume extra space. So this variable ought to be considered before planning the vehicle so that this component could be survived. Coordinating regenerative slowing down into a vehicle requires a few changes in the driving style which relies upon the specialized design of the layout. This requires some investment in becoming accustomed to, however studies have shown that drivers answer emphatically and attempt to expand the energy they can recover and thus broaden their reach.

Furthermore, the utilization of regenerative slowing down is firmly connected to eco-driving. On the off chance that eco-driving techniques are applied by countless drivers, this could impressively affect traffic streams.

## **8. CONCLUSION**

The regenerative stopping mechanism utilized in vehicles fulfills the reason for saving a piece of the energy lost during slowing down. The regenerative slowing mechanism is intended to somewhat recuperate the battery charge squandered in slowing down of the vehicle. The energy is changed over into heat by contact brakes which are scattered to the climate. This Energy is used to pivot the rotor of the generator changing over mechanical energy of wheels into helpful charge of battery. Without a doubt, these vehicles might utilize petroleum products at the reenergizing stage. That is, assuming the wellspring of the power comes from a petroleum product like coal yet when they're out there out and about, they can work without really any utilization of non-renewable energy sources by any stretch of the imagination, and that is a major forward-moving step. All vehicles moving can profit from using recovery to recover energy that sounds lost, really. Regenerative stopping mechanisms have a critical opportunity to get better. Regenerative slowing down is still extremely restricted and reliant upon wild factors. In any case, regenerative slowing down has different advantages. A legitimate execution of regenerative slowing mechanism expands driving reach, improves slowing down effectiveness, decreases brake wear, and further develops energy protection

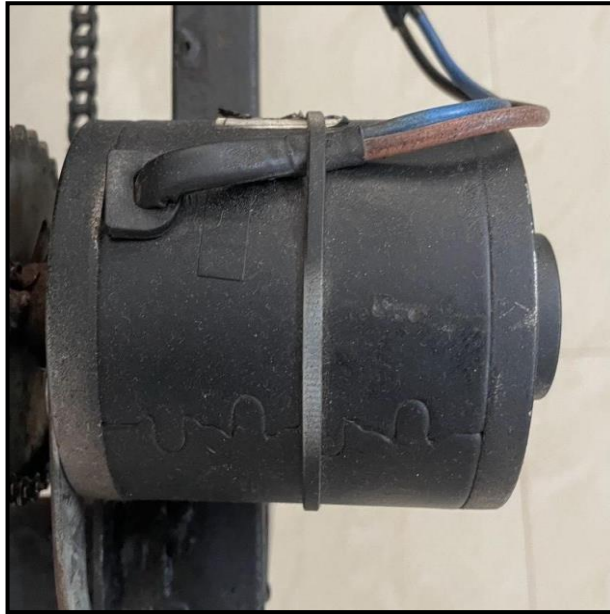
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## CHAPTER - 10

### PHOTOGRAPHY OF THE PROJECT



(a) 12V DC MOTOR



(b) GENERATOR MOTOR



**(c) CHAIN SPROCKET**



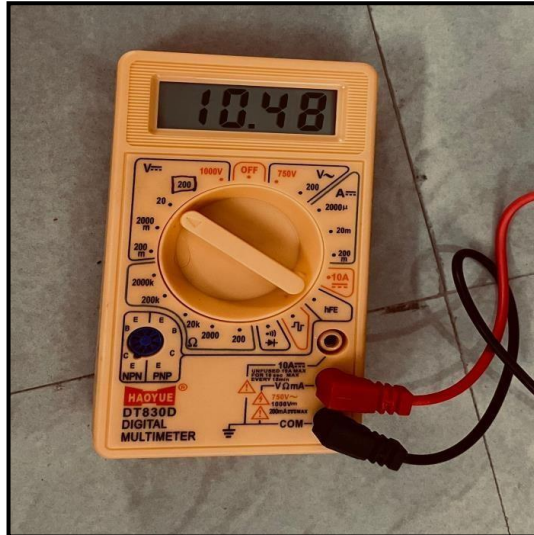
**(d) GEARS**



**(e) FLYWHEEL WITH BRAKE SPINDLE**



**(d) 12V BATTERY**



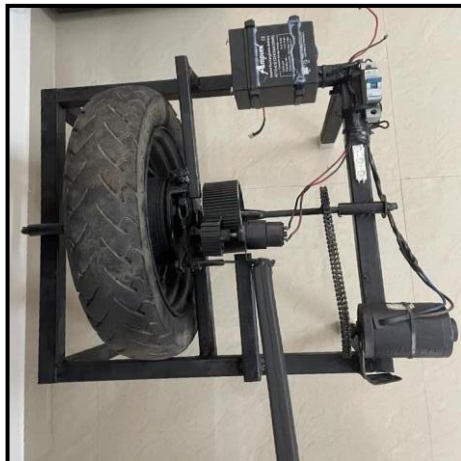
**(e) MULTIMETER**



**(f) MCB SWITCH**



**(g) CONNECTING WIRES**



**(h) ASSEMBLY OF REGENERATIVE BRAKING SYSTEM**