

# Flywheel Based Regenerative Braking In Two Wheelers

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**Abstract**— Generally braking plays an important in two wheelers, without braking we cannot slow down the two wheelers. In existing there are several model of regenerative braking system based on electrical system. Conventional regenerative braking is a system in which the electric motor that normally drives a hybrid or pure electric vehicle is essentially operated in reverse (electrically) during braking or coasting. Instead of consuming energy to propel a vehicle, the motor acts as a generator that charges the on board batteries with electrical energy that would normally be lost as heat through traditional mechanical friction brakes. As the motor “acts in reverse,” it generates electricity. The accompanying friction (electrical resistance) assists the normal brake pads in overcoming inertia and helps slow the vehicle.

In this project, a model of regenerative braking system using flywheel in two wheelers is proposed. It works on the fact that the back wheel is connected to the flywheel using the chain drive. There is also a disk brake which is connected near the flywheel which is connected to the brake wire of back wheel. The working principle involved in this project is that when the brake is applied to the wheels, brake wire disengages the flywheel and the power is shifted to the flywheel and it consumes the energy. When the brake is released the consumed energy is transferred to the back wheel which gives extra energy to start the two wheelers.

**Keywords**—Braking,Flywheel,Energy Conservation ,Efficiency

## I. INTRODUCTION

Brakes are essential to safely operating a motor vehicle. Without the ability to slow and stop our vehicles, accidents would occur at every stoplight, yield sign and drive-thru in America. The way brakes are built has evolved over time, but modern **braking systems** are comprised of service brakes, parking brakes and emergency brakes. Each type of brake is involved in particular activities in a motor vehicle, and drivers should be familiar with how to operate

each safely. Understanding the parts that can compose a brake will help when learning about the different types of brakes used in a modern braking system. Proper maintenance can prevent brake failure by stopping causes of sticking, corrosion and piston failure. If you have been injured by another's negligence concerning brake maintenance, an experienced auto accident attorney can help you determine the most appropriate course for legal action.

### A. Service Brake Characteristics

There are three common characteristics of service brake systems that can be found in modern day vehicles which are explained below :

**Friction** created between one of the two components namely the soles or pads is the most common configuration in service brakes used today.. Both include a rotating device with a stationary pad and rotating wear surface.

**Pumping** brake includes a pump within the machinery and may use an internal-combustion piston motor to cut off the fuel supply to the vehicle, leading to internal pumping losses to the engine, that in turn causes braking.

**Electromagnetic** brake may use an electric motor already built-in with the vehicle. Many hybrids use this technology for regenerative brakes. Some buses may also use a generator with an internal short circuit called a secondary retarder brake.

There is a variety of different braking systems that can be found on a vehicle, depending on its use, size and weight. Brake systems, whether powered by air, hydraulics or computer, are engineered for automotive safety. Service brakes allow drivers to stay safe while maneuvering their vehicle in ordinary driving situations. Another form of brakes makes up the system in a passenger vehicle, in order to protect from a collision while stopped parking brakes.

## B. Parking Brakes:

A parking brake allows for a vehicle to remain stationary when parked on an inclined or flat surface, and prevents rolling while a vehicle is not in operation. The parking brake is usually operated by a small pedal near the driver's side door beneath the steering column, or by a lever in the center console, either requiring mechanical force to operate. Some newer-model vehicles have replaced these devices with a simple button. The mechanism uses a latching system with a cable that directly connects the brakes to the pedal or lever inside the vehicle's cab, which in turn uses a ratchet-locking device. Usually, the cable used in a parking brake will bypass the service braking system to ensure the vehicle is able to stop in the event of service brake failure.

## C. Emergency Brakes:

The parking brakes double as emergency brakes, so the mechanisms used to control both are the same. The difference in the terms is situational, and the way the vehicle responds when using the parking brake as an emergency brake can be extremely different than using service brakes. When the parking/emergency brake is applied in a vehicle, the cable connecting the device and the brake system passes to an intermediate lever, which causes the force to increase while passing through a part called an equalizer. The equalizer then splits the cable in two, and divides the force between the rear wheels to slow the automobile.

Because emergency brakes are only applied to the rear wheels, when they are used while a vehicle is in motion, it is likely that the brake balance of the car may be upset, which can contribute to loss of control. It is also probable that the force applied by the emergency brake may not be sufficient to stop the vehicle. Emergency brakes are intended for use in cases of service brake failure as a means of backup.

## D. Electric Power Generation:

The AC power generated in 3 phase system as 3-phase AC **electric power generation** is the most economical. 3 phase AC generator is commonly known as the alternator. An alternator has balanced three phase winding on its stator and an electromagnetic field is rotated inside the stator.

Due to this system, rotating magnetic field cuts the stator winding's conductor and as a result, electricity is induced in the stator windings. From terminals of the stator three phase power is obtained. In an alternator, rotating electromagnet is energized by the DC source. The rotor is driven by some external means with the help of thermal, hydel, wind or other forms of energy. For example, in thermal power plant, the rotor of the alternator is rotated by means of a turbine shaft and the turbine is driven by means of high temperature and pressure steam. The steam is produced in a boiler by burning coal in the furnace.

As the stator winding is perfectly balanced, the three phase power produced in an alternator is also balanced that means phase difference between two conjugative phases is 120 degrees (electrical).

## II. LITERATURE SURVEY

### Chandrakant Rahane, Vaibhav Varpe, "Design and fabrication of regenerative braking system"

In recent years, increased concerns over the impact of the conventional car (ICE – Internal Combustion Engine) on the environment have led to renewed interest and advancement in the Electric Vehicle (EV). While the advancements in the EV technology have been able to overcome many of its initial limitations, the need to improve overall efficiency of the vehicle has led to the design of the regenerative braking system (RBS). The RBS will be used to convert the car's mechanical energy and also the heat that would have been lost during braking into electrical energy. The RBS would be controlled using a PWM (Pulse Width Modulation) signal generated from a microcontroller. The duty cycle of the PWM signal would in turn depend on the response to a variable resistor which will be used to model the conventional braking. A higher resistance would generate a PWM signal with a higher duty cycle and in turn, a higher braking intensity. Therefore, by varying the resistor value, the braking intensity can also be varied. The motor to be used in this system will primarily be a DC Motor. We intend to switch to an induction motor later on as this is currently the norm in the BEV (Battery Electric Vehicle) industry. In other term to maximize the efficiency of the RBS, it is important that we store

some of the energy that may have otherwise been wasted. To achieve this, we implement the use of large capacitors connected in parallel to store the energy. This energy could then be used to recharge the batteries of the Electric vehicle (EV).

D.Kesavaram, K.Arunkumar, M.Balasubramanian, J.Jayaprakash, K.Kalaiselvan, **“Design and Fabrication of Regenerative Braking System and Modifying Vehicle Dynamics”**

A regenerative brake is an energy recovery mechanism which slows a vehicle or object by converting its kinetic energy into a form which can be either used immediately or stored until needed. The conventional brake setup involves many energy losses and hence in our work, the conventional brake setup is replaced by mounting an alternator assembly in the wheel hub. During the forward motion of the vehicle, the alternator's rotor rotates freely. During the application of brakes, the input supply is given to the alternator and as a result the rotor coils provide a rotational magnetic flux which cuts the stator conductor which is rotating along with the flywheel and hence an induced voltage is obtained from the alternator output which is stored in a battery. By increasing the alternator load the conductor gradually slows down and hence acts as a brake. The time required to stop the vehicle is directly proportional to the load connected to the alternator. Then by increasing the diameter of the front wheel of the

vehicle, the stability of the 2 wheeler can be improved as it modifies the rear suspension effect and provides more contact between the wheel and the ground during braking. The suspension action can also be utilized for any useful purpose by placing a piston and cylinder arrangement having one-way valve lead to compressed air tank.

Sandeep Dilip Mistry, Rohan Vijay Rane, **“Design analysis and fabrication of regenerative braking system”**:

A regenerative braking system is an energy recovery system that reduces vehicle speed by converting some of its kinetic and potential energy into a useful form of energy instead of dissipating it as heat as in the case of a conventional braking system. The converted kinetic energy is stored for future use or is fed back into the power system of the vehicle. This energy can be stored in a battery or bank of capacitors for later use. Energy can also be stored with the help of a rotating flywheel which is one of the most inexpensive and effective method of storing and regenerating power. The present invention provides energy-storing regenerative braking system by transmitting the flywheel force as a torque tending to oppose the forward rotation of a wheel on applying the brakes. A brake-pad assembly, mounted concentrically with the hub of a ground-engaging wheel, is actuated upon braking to provide frictional engagement between the hub and clutch mechanism, while applying a decelerating torque to the wheel. The clutch mechanism is engaged only upon braking and does not interfere with wheel rotation during other vehicle operating modes. 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. The transfer of energy to the load provides the braking effect and regenerates power.

Mragank Sharma, Anshul Verma, Gaurav Tiwari, Sunny Singh, Mohd Nadeem , **“Design and Fabrication of Regenerative Electric Bike”**:

The constant global hunt to store the energy and convert it into other useful form since the need of development of new technologies and system to explore in new way as in an electric bike great amount of kinetic energy lost into the atmosphere during breaking in the form of heat energy due to friction between brake shoe and the brake drum. This paper presents a way to design and fabrication of regenerative electric bike using regenerative braking system. Regenerative braking refers to a process in which a portion of the kinetic energy of the bike is stored for a short term by the storage system. To gain the power, we assemble the brushed dc motor, l-clamp iron bar and frictional pulley clamp above the hub of front pulley. As we apply brake, system actuated as the frictional pulley meshed with the center hub of wheel which rotates frictional pulley in opposite direction of the wheel due to which the armature of dc motor rotates and convert mechanical work into useful electrical energy (charge) which is stored in the battery.

Additional energy increases the discharging time of battery so that electric bike can move long distance. Hence efficiency of the bike is improved. In present time, some elevator/lift systems use regenerative braking also.

Sayed Nashit, Sufiyan Adhikari, Shaikh Farhan, Srivastava Avinash, Amruta Gambhire, **“Design, Fabrication and Testing of Regenerative Braking Test Rig for BLDC”**

## Motor”:

In this project work a test bench for testing of regenerative braking capability of a Brushless DC Motor is design and then fabricated. The thesis discusses in detail about the steps carried out in designing the test rig and its fabrication. The BLDC Motor used in the project for the test rig is an industrial grade BLDC Motor imported from China. The BLDC Motors are found to be more efficient at higher speeds and the regenerative braking is more effectively applied only at higher speeds. It can have concluded from this intensive project that the regenerative braking cannot be used are the sole way of braking in electric and hybrid vehicles and only small part of a vehicles kinetic energy can be recovered.

## Oscar Rodrigues, Omkar Taskar, Shrutika Sawardekar, Henderson Clemente, Girish Dalvi , “Design & Fabrication of Eddy Current Braking System”:

Majority of braking systems work on the principle of dissipation of kinetic energy to heat energy. This method has its own drawbacks and must be replaced with a more reliable braking system that is quick in response, doesn't heat up and is maintenance free. In this project the design an eddy current braking system and optimization for various operational parameters has been done. These parameters have been previously iterated in cited projects and papers and also in the simulation models and are to be cross-checked with the experimental setup.

## Tejas Gulab Borhade, Atul More, Vikrant Ullhas Garud , “Design and Fabrication of Regenerative Shock Absorber System for Vehicle to Optimize Fuel Economy”:

In today's entire world is surrounded by carbon which is mainly responsible for global warming. This is because Fossil fuels are being consumed with very fast rate and there is necessity of in-built alternative energy source which can fulfill the energy requirement of vehicle. Even though a wide experimentation has done on IC engine efficiency optimization but there is a still wide scope for regeneration of energy through regenerative shock absorber system and so on. Eventhough reciprocating distance is very low but the suspending mass is very high i.e. the mass of total vehicle. Utilization of this reciprocating motion of shock absorbers and high suspending mass of vehicle can be possible and accordingly thought process has initiated. In the experimental model, A small gearbox is attached to alternator of automobile and due to reciprocating motion of shock absorbers when vehicle will pass through a dump or pit, electricity has generated of about 13 volts for 500kg to

2000kg loading range for 100 kilometer distance travelled and about vertical lift (up and down motion of about 10mm) and after implementation it has found that fuel economy can be optimized by 3.5 % as batteries are replaced by Regenerative shock absorber system.

### III. EXPERIMENTAL SETUP

#### A. DC Motor :

The electrical motor is an instrument, which converts electrical energy into mechanical energy. According to Faraday's law of Electromagnetic induction, when a current carrying conductor is placed in a magnetic field, it experiences a mechanical force whose direction is given by Fleming's left hand rule.

Constructional dc generator and dc motor are identical. The same dc machine can be used as a generator or as a motor. When a generator is in operation, it is driven mechanically and develops a voltage. The voltage is capable of sending current through the load resistance. While motor action a torque is developed. The torque can produce mechanical rotation. Motors are classified as series wound, shunt wound motors.

In DC machines coils are wound on the armature core, which is supported by the bearings, enhances rotation of the armature. The commutator periodically reverses the direction of current flow through the armature. Thus the armature rotates continuously. An electric motor is all about magnets and magnetism: a motor uses magnets to create motion. If you have ever played with magnets you know about the fundamental law of all magnets: Opposites attract and likes repel.

**B. Battery :**

In isolated systems away from the grid, batteries are used for storage of excess solar energy converted into electrical energy. The only exceptions are isolated sunshine load such as irrigation pumps or drinking water supplies for storage. In fact, for small units with output less than one kilowatt. Batteries seem to be the only technically and economically available storage means. Since both the photo-voltaic system and batteries are high in capital costs. It is necessary that the overall system be optimized with respect to available energy and local demand pattern

**C. DC Generator :**

A DC generator is an electrical machine which converts mechanical energy into direct current electricity. This energy conversion is based on the principle of production of dynamically induced emf.

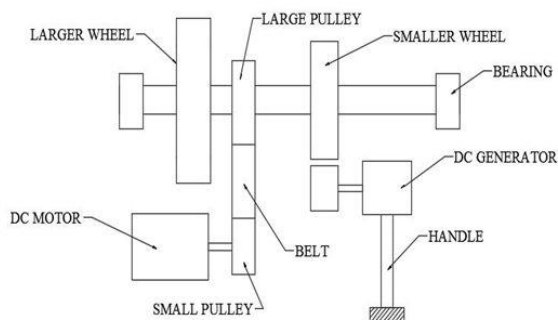
According to Faraday's laws of electromagnetic induction, whenever a conductor is placed in a varying magnetic field (OR a conductor is moved in a magnetic field), an emf (electromotive force) gets induced in the conductor. The magnitude of induced emf can be calculated

from the emf equation of dc generator. If the conductor is provided with the closed path, the induced current will circulate within the path. In a DC generator, field coils produce an electromagnetic field and the armature conductors are rotated into the field. Thus, an electromagnetically induced emf is generated in the armature conductors. The direction of induced current is given by Fleming's right hand rule.

According to Fleming's right hand rule, the direction of induced current changes whenever the direction of motion of the conductor changes. Let's consider an armature rotating clockwise and a conductor at the left is moving upward. When the armature completes a half rotation, the direction of motion of that particular conductor will be reversed to downward. Hence, the direction of current in every armature conductor will be alternating. If you look at the above figure, you will know how the direction of the induced current is alternating in an armature conductor. But with a split ring commutator, connections of the armature conductors also get reversed when the current reversal occurs. And therefore, we get unidirectional current at the terminals.

**IV. RESULTS AND DISCUSSIONS**

The experimental setup consists of larger wheel which is mounted on the shaft which is connected rigidly mounted with the help of bearing, now the wheel is rotated with the help of connected dc motor which is powered by means of battery. During the rotation of wheel the small wheel connected with this attachment also rotates. When the brake lever which consists of dc generator and friction wheel attachments is contacted against the small wheel, due to this friction gets generated against the wheel which causes the friction wheel to rotate there by rotating the generator in order to generate electricity, the generated electricity is stored in the battery which activates the led. The stored power is used for consumer purposes.



*Block Diagram of the Experimental setup*

**V CONCLUSION**

Thus, the Flywheel based regenerative braking in two wheelers helps to increase the efficiency of the vehicle by 20% by conserving the Kinetic energy lost during brakes and optimizing it. The operating procedure of this system is

very simple, so any person can operate. By using more techniques, they can be modified and developed according to the applications. This can be widely employed for minimising the energy consumed in automobiles.

## REFERENCES

- 1.G.B.S. Narang, "Automobile Engineering", Khanna Publishers, Delhi, 1991, pp 671.
- 2.William H. Crowse, "Automobile Engineering".
- 3.Chandrakant Rahane, Vaibhav Varpe , "Design and fabrication of regenerative braking system"
- 4.D.Kesavaram, K.Arunkumar, M.Balasubramanian, J.Jayaprakash, K.Kalaiselvan , "Design and Fabrication of Regenerative Braking System and Modifying Vehicle Dynamics"
- 5.Sandeep Dilip Mistry, Rohan Vijay Rane , "Design analysis and fabrication of regenerative braking system"
- 6.Mr. Mragank Sharma, Anshul Verma, Gaurav Tiwari, Sunny Singh, Mohd Nadeem , "Design and Fabrication of Regenerative Electric Bike"
- 7.Sayed Nashit, Sufiyan Adhikari, Shaikh Farhan, Srivastava Avinash, Amruta Gambhire , "Design, Fabrication and Testing of Regenerative Braking Test Rig for BLDC Motor"
- 8.Oscar Rodrigues, Omkar Taskar, Shrutika Sawardekar, Henderson Clemente, Girish Dalvi , "Design & Fabrication of Eddy Current Braking System"
- 9.Tejas Gulab Borhade, Atul More, Vikrant Ullhas Garud , "Design and Fabrication of Regenerative Shock Absorber System for Vehicle to Optimize Fuel Economy"