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Design and Fabrication of Regenerative Braking System using Flywheel to Charge the Batteries in EV

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Abstract: *This paper shows how to make and use a wheel that spins fast to save energy when the car stops and use it to fill up the power cells in cars that run on electricity. Regenerative braking is a new way of saving and changing the power of movement when the car slows down into electricity that can be used. The old way of making cars stop wastes energy as warmth, making them work badly and put more bad gas in the air. The new way of stopping the car uses an electric machine to make it go slower, making a force that slows down the wheels and changes the movement power into electricity power. The saved power can be used to run the car's electric things or kept in power cells for another time.*

Keywords: regenerative braking, flywheel, electric vehicle, kinetic energy recovery system, sustainability, energy efficiency;

I. INTRODUCTION

1.1 Regenerative Braking

Regenerative braking is a new way of saving energy when the car stops. In the last years, this way has become more popular as car makers want to make their cars work better and not harm the earth. The old way of stopping the car is not good because it wastes energy as warmth. This makes the car work badly and put more bad gas in the air. Regenerative braking helps to fix these problems by saving the energy of movement and changing it into electricity that can be used. This way works by using an electric machine to make the car go slower instead of only using old brakes. When the driver stops, the electric machine makes a force that slows down the car. When the driver stops, the electric machine makes a force that slows down the wheels and changes the car's movement power into electricity power. Regenerative braking is a way that saves the energy that is lost when the car stops and changes it into electricity.This electricity can be used to run the car's electric things or kept in a power cell for another time. This way is very good in city driving where there is a lot of stopping and starting. In times where cars often go faster and slower, regenerative braking can save a lot of energy that would be wasted. But, regenerative braking is not good at high speeds, where old brakes are still needed to make the car go slower fast. Regenerative braking is very important for cars that use both electricity and petrol or only electricity. It helps to make them work better and go longer. Cars that use both electricity and petrol use this way to fill up their power cells and use less petrol. But, cars that use only electricity use regenerative braking as their main way of stopping because they do not have old brakes. Regenerative braking helps to make the power cells last longer and make the cars go farther on one fill up. Another good thing about this way is that it makes the car's brake parts last longer, which can save money on fixing costs. Since regenerative braking uses less old brakes, there is less rubbing and warmth made when stopping, which makes the need for fixing and changing costs less.

1.2 Flywheel Based Regenerative braking

A type of regenerative braking that employs a flywheel to conserve energy when braking is called flywheel-based regenerative braking. This technology has attracted the interest of carmakers and researchers because of its ability to enhance the vehicle's efficiency and eco-friendliness. Flywheel-based regenerative braking operates by using an electric motor to decelerate the vehicle and transfer the kinetic energy to a flywheel that spins. The flywheel then preserves the energy as rotational energy, which can be later utilized to power the vehicle's electrical systems or assist in acceleration.The flywheel then preserves the energy as rotational energy, which can be later utilized to power the vehicle's electrical systems or assist in acceleration. The flywheel can rotate at extremely high speeds, enabling it to

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conserve a considerable amount of energy in a small space. One of the benefits of flywheel-based regenerative braking is that it is light and compact. In contrast to conventional battery-based regenerative braking, flywheel-based systems do not need large and heavy batteries, which can add to the weight and size of the vehicle. This technology is especially suitable for sports cars and high-performance vehicles, where weight and size are essential factors in performance. Nevertheless, flywheel-based regenerative braking has some drawbacks. One of the drawbacks is that it needs a relatively steady speed to function efficiently. This implies that flywheel-based systems are less effective in stop-and-go driving conditions, where vehicles often accelerate and brake. Moreover, flywheel-based systems can be costly to produce and need advanced technology to ensure the flywheel rotates at high speeds without harming the system.

II. METHODOLOGY

2.1 STUDYING THE CONVENTIONAL MECHANISM OF FLYWHEEL

Examining the conventional mechanism of flywheel is a crucial step in comprehending the fundamental principles of flywheel-based regenerative braking. In this step, researchers scrutinize the design and operation of traditional flywheel systems to pinpoint the key components and functions that enhance their performance. The conventional mechanism of a flywheel involves a heavy rotating disk that conserves kinetic energy. The flywheel is typically mounted on a shaft and rotates at high speeds, enabling it to conserve a considerable amount of energy in its rotational motion. The energy conserved in the flywheel can be utilized for various applications, including energy storage, power generation, and momentum transfer.

2.2 DESIGN THE MECHANISM OF FLYWHEEL

Creating the mechanism of a flywheel is a vital step in developing a flywheel-based regenerative braking system. This step involves the production of a detailed design specification that delineates the key components, materials, and manufacturing processes needed for the flywheel mechanism. The design specification for a flywheel mechanism typically comprises several key elements, such as the size and weight of the flywheel, the type of material employed for construction, the shape and configuration of the flywheel, and the bearings and other supporting components needed to ensure stability and balance

2.3 DESIGN OF CAD MODEL

Creating the mechanism of a flywheel is a vital step in developing a flywheel-based regenerative braking system. This step involves the production of a detailed design specification that delineates the key components, materials, and manufacturing processes needed for the flywheel mechanism. The design specification for a flywheel mechanism typically comprises several key elements, such as the size and weight of the flywheel, the type of material employed for construction, the shape and configuration of the flywheel, and the bearings and other supporting components needed to ensure stability and balance.

2.4 MATERIAL SELECTION FOR MECHANISM

Choosing the suitable materials for the mechanism of a flywheel-based regenerative braking system is a vital step in the development process. The choice of materials can have a considerable impact on the performance, durability, and overall cost-effectiveness of the system.

2.5 PERFORM SIMULATION USING FUSION 360

Conducting simulations using advanced CAD software, such as Fusion 360, is a vital step in the development of a flywheel-based regenerative braking system. Simulation enables designers to test the performance and behavior of the system under a range of different conditions, providing valuable insights into its functionality and potential areas of improvement. In Fusion 360, designers can produce a detailed digital model of the flywheel mechanism, including all supporting components such as bearings, bushings, and the braking system itself. This digital model can then be used to conduct advanced simulations to evaluate the performance of the system under different loads, speeds, and other operating conditions.

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2.6 FABRICATION OF MECHANISM

The production of the flywheel mechanism is a vital step in the development of a flywheel-based regenerative braking system. This step involves the actual construction of the physical mechanism, based on the design and specifications developed in earlier steps. The production process typically involves a range of different techniques and processes, including machining, welding, and assembly. Depending on the materials used and the complexity of the design, the production process may involve multiple stages and require specialized equipment and expertise

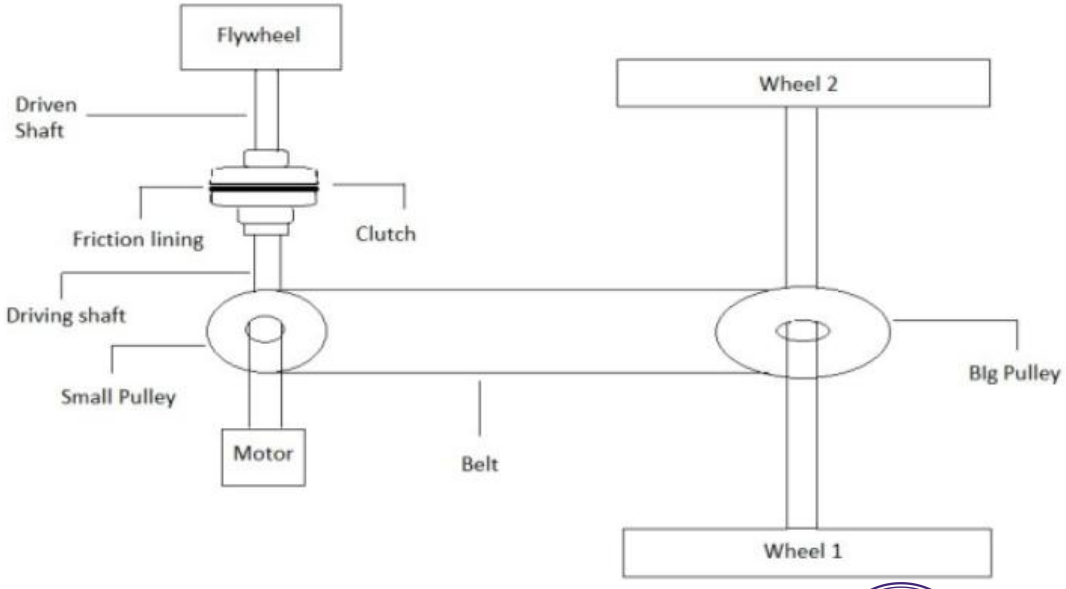
III. LITERATURE SURVEY

P.VeeraRaju created and produced Kinetic energy recovery system through mechanical brakes which demonstrate a designed model in 3D Experience software. Any auxiliary energy transfer or energy conversion equipment must be efficient, compact, and reasonably priced, and the energy storage unit must be compact, durable, and capable of handling high power levels efficiently. This chapter discusses the project's background, including the issue statement, objectives, and scope. All of this information is necessary to provide a starting point for the project's progress. The aim of this project is to use CATIA design software to create and produce a regenerative braking system employing mechanical brakes [1].

Thomas Matthews implemented the KERS system integrated in vehicles. The project used a flywheel for transfer of energy from moment of braking back to the battery unit. The flywheel KERS system has the potential to be a game-changing technology. It enhances the power of all vehicles while also improving their fuel efficiency. A cleaner, greener environment is directly proportional to improved fuel economy. It has a positive influence on the environment since it reduces harmful CO2 emissions. The amount of CO2 emitted during the construction of one flywheel KERS has been determined to be recovered during the first 12,000 km of driving. Furthermore, unlike a hybrid electric vehicle, a mechanical hybrid powered by a flywheel does not require the disposal of hazardous chemicals present in batteries [2].

RohanRane and SandeepMistry created a light, compact and inexpensive system. In a regenerative braking system, the regenerative brake recovers around half of the wasted energy and uses it to power the engine, whereas traditional brakes waste 80% of the overall energy. A regenerative braking system reduces fuel consumption by 10% to 25%. Regenerative braking has also been demonstrated to enhance fuel economy — by as much as 20% – at higher speeds. Regenerative braking is a minor but vital step toward our eventual fossil-fuel independence. Batteries with these types of brakes can be used for longer periods of time without needing to be charged externally. The driving range of fully electric vehicles is also increased by using these types of braking systems.

IV. WORKING OF THE SYSTEM



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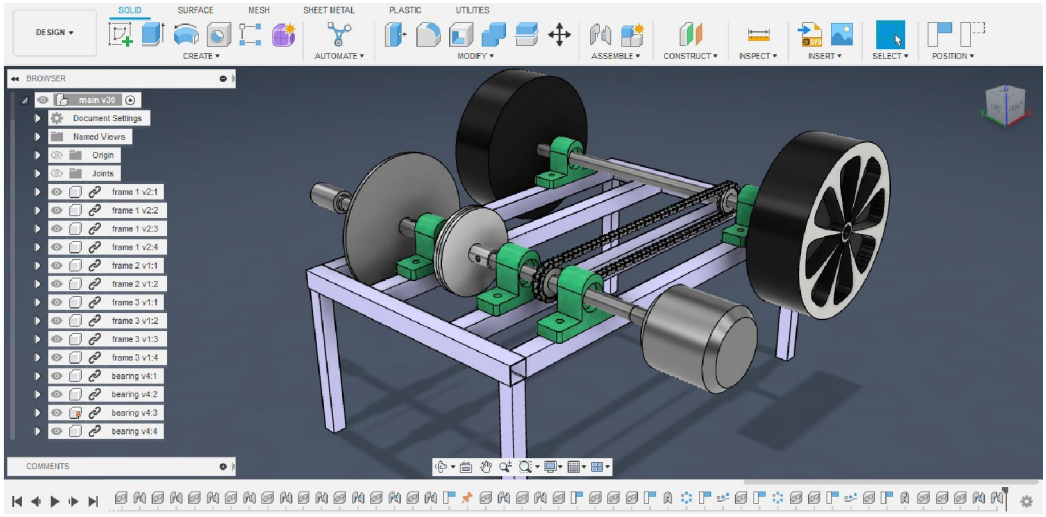
In electric vehicles, motor is the prime mover. Motor transfers the energy to the wheels which keep the vehicle moving. Under normal circumstances, the clutch is disengaged from the main system comprising of motor, transmission, and wheels. The Flywheel which will be used to regenerate is mounted on a separate shaft. The motor shaft and flywheel shaft are not connected when the vehicle is running. Now, after applying brakes, it pushes the clutch plate axially. This clutch plate comes in contact with the friction plate mounted on flywheel shaft and it starts rotating. The kinetic energy of the wheels through the same transmission system is now been transferred to flywheel via the engagement of clutch. The rotation of flywheel leads to an increase in the moment of inertia of the vehicle, which helps to decelerate the vehicle. This rotational kinetic energy stored in the Flywheel can then be converted into electrical energy with the help of an Alternator., Thus clutch plate and friction plate disengages and the vehicle can be accelerated again using motor.

V. ASSEMBLY OF THE COMPONENTS

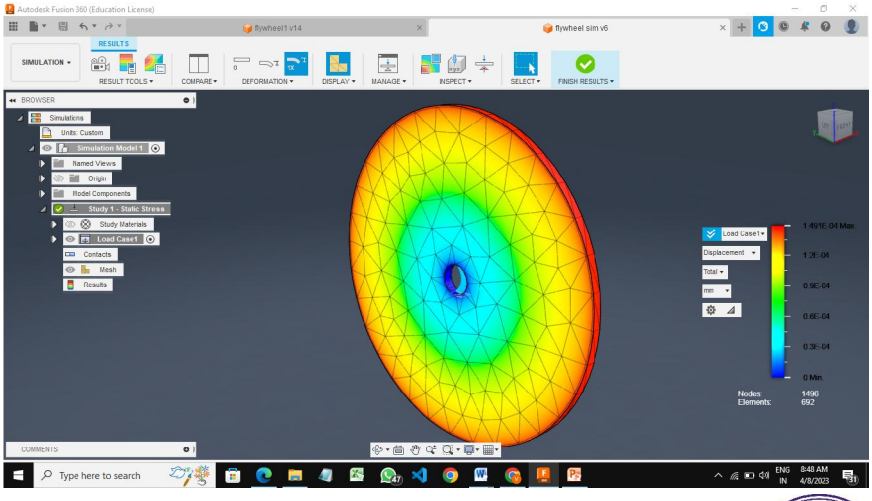
All the above components of the assembly have been designed in Fusion 360 software. The results of the calculations above have been used to create a ComputerAided Design of each major individual component. Then, all the components have been combined into a Fusion assembly, and colorful features have been added to each component to make the model easily to understand and analyze.



Simulation

Some of the components in the assembly will be subjected to lots of structural stresses. Hence, proper analysis is required with all the given conditions to simulate under various cases of failure. This will assure that the system is free from failure. The Analysis of the components of the system is done in AUTODESK FUSION 360 software

ANALYSIS OF FLYWHEEL



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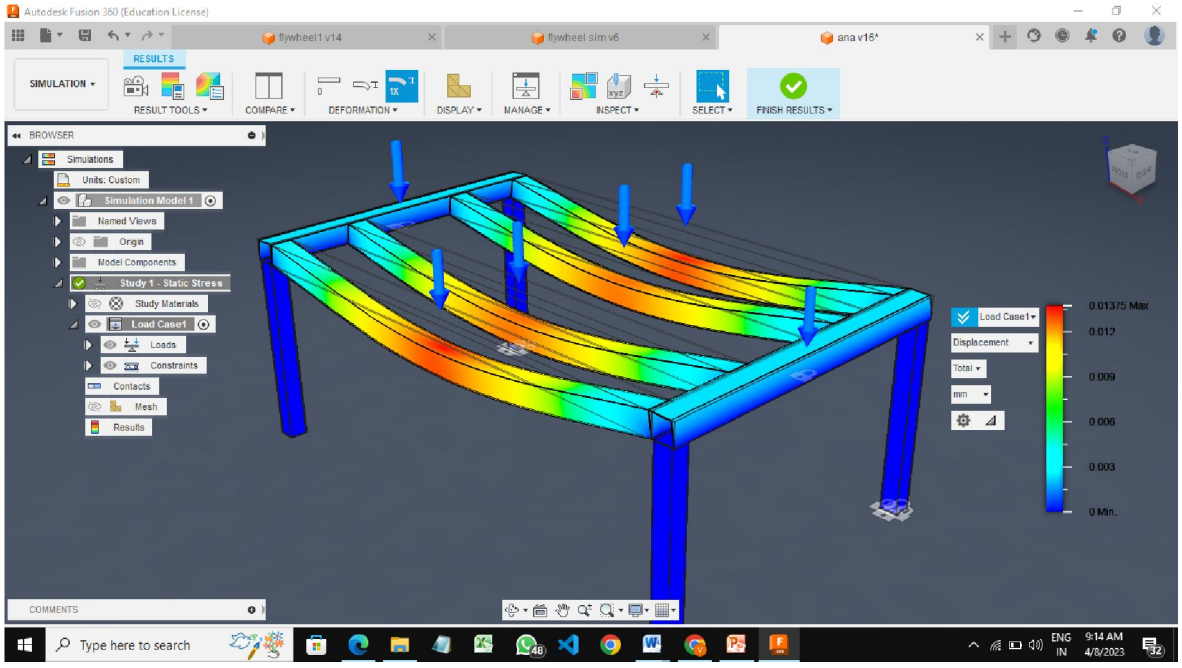
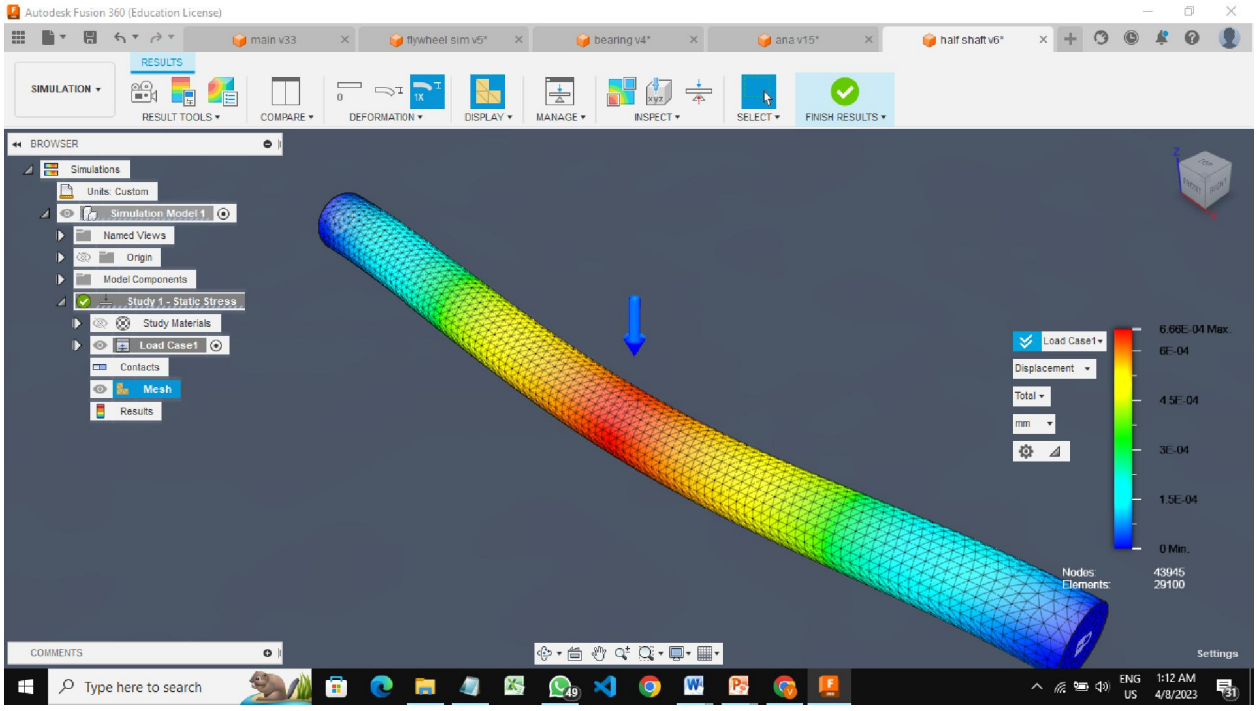
ANALYSIS OF FRAME



ANALYSIS OF BAR



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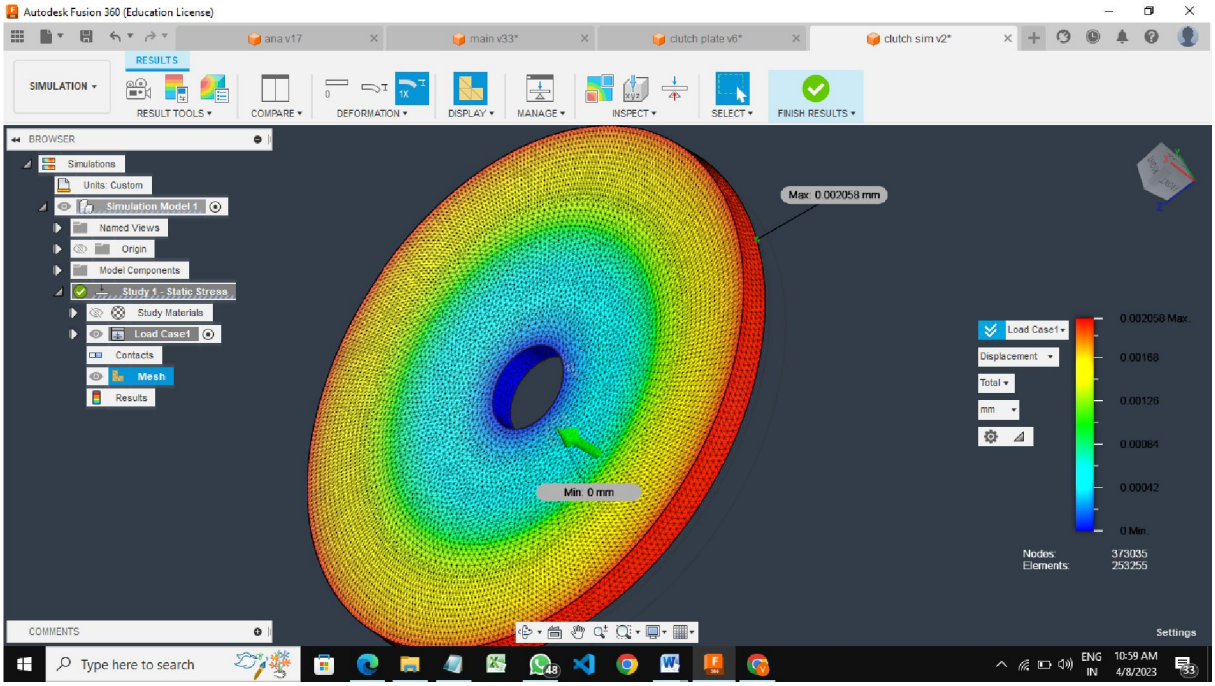
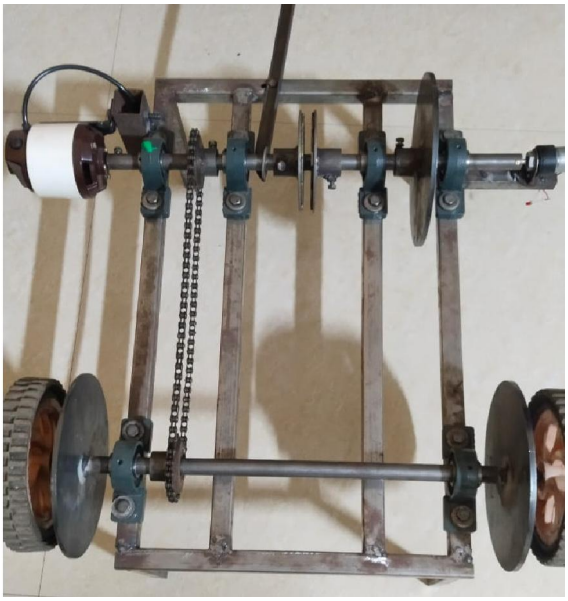
ANALYSIS OF CLUTCH



Actual model

ACTUAL MODEL PHOTO



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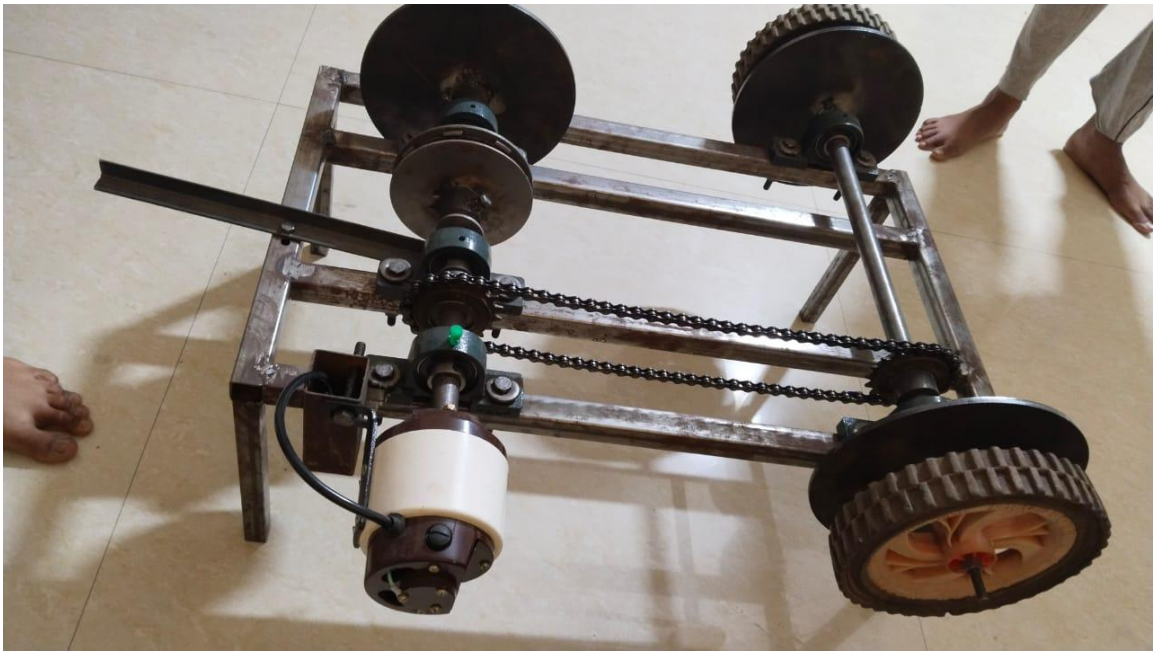

VI. CONCLUSION

A preliminary design of a Kinetic Energy Recovery System (KERS) has been conducted, encompassing all aspects of energy transmission and regeneration from brake energy that would otherwise go to waste. The design calculations have been carried out according to established reference materials, and each component has been modeled in Fusion 360 before being assembled. The simulation section of Fusion 360 has been utilized to analyze the performance of each major component and ensure that it can withstand any potential failure conditions. It is anticipated that this proposed concept and design will serve as a catalyst for the development of more affordable and accessible electric vehicles within the industry.

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