

Review and Design Analysis of Single Roller Regenerative Brake system

Mr Mukesh Tarone, Prof Manoj Sharma

¹ Masters Student, .mechanical department, Rajiv Gandhi Proudtyogiki Vishwavidyalaya Bhopal (M.P.)

² Assitant prof.mechanical department, Rajiv Gandhi Proudtyogiki Vishwavidyalaya Bhopal (M.P.)

ABSTRACT

Regenerative braking system is a system for recovering the moving vehicle's kinetic energy under braking load (ie, when brakes are applied) and to convert the this loss in kinetic energy of vehicle which usually would be wasted and dissipated as heat in the brakes into useful form of energy either mechanical or electrical. Conventional regenerative braking systems available in the market are converting the loss in kinetic energy of the vehicle into electrical energy that is stored in battery for further use. It is important to note that the kinetic energy available as mechanical energy is first converted to electrical energy and is stored in the battery ...and then this energy is again converted form electrical energy to mechanical energy by use of motor. Present day regenerative braking systems make use of motor-generator setup for this purpose. Commercial cars due to space occupied , cost , and handling of this energy and utilization is difficult as the commercial cars may encounter frequent braking at short intervals. Hence there is a need of a innovative system to tap the usually wasted loss of kinetic energy to suitable mechanical energy .The proposed mechanical to electrical regenerative braking uses a innovative planetary gear train and dedicated drum brake system to recover the loss of kinetic energy from the wheel hub of the vehicle and convert it to electric energy through a flywheel ad dynamo arrangement. This system is compact , practical and a low cost solution that converts the loss of kinetic energy of vehicle during braking and stores it as electrical energy and gives minimal loss in transmission there by leading to better efficiency and better conversion ratio as compared to any other earlier braking system using motor-generator set up. . 3-d Cad model of system for optimal energy recovery capacity , optimal factor of safety , using Unigraphics Nx-8.0 and CAE of critical component such as the input drum shaft , flywheel gear and friction roller is done meshing using Ansys Work-bench 16.0 is done in the present study.

Keyword : - Regenerative Braking , Momentum , Electrical energy , Storage Battery

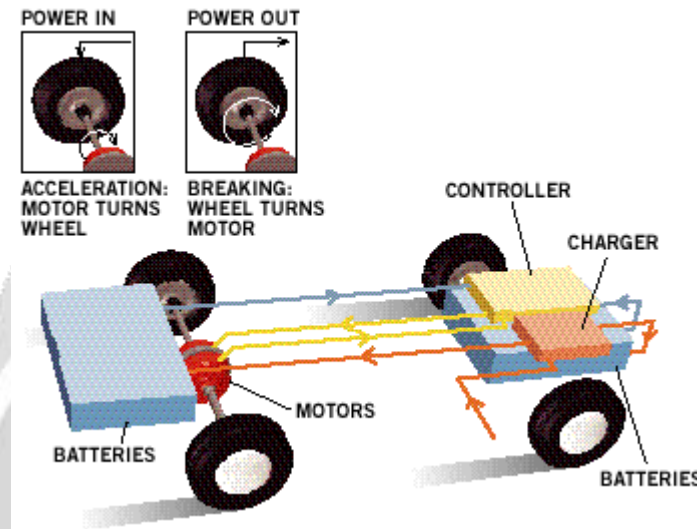
INTRODUCTION

Kinetic energy recovery system is used on hybrid gas/electric automobiles to recoup some of the energy lost during retardation or stopping . This energy is converted in to electrical energy and saved in a storage battery for later use to power the motor whenever the car is in electric mode. Conventionally when the brake pads rub against the wheels (or a disc connected to the axle), excessive heat energy is also created. This heat energy dissipates into the air, wasting up to 28 to 30% of the car's generated power. The car's fuel efficiency is reduced over time owing to this cycle of friction and wasted heat energy. More energy from the engine is required to replace the energy lost by braking.

Electric motors and electric generators (such as a car's alternator) are essentially two sides of the same technology. Both use magnetic fields and coiled wires, but in different configurations. Regenerative braking takes advantage of this dual nature and whenever the electric motor of a hybrid car begins to reverse direction, it becomes an electric generator or dynamo to generate electricity which is fed into a storage battery for later to power the car .

Regenerative braking system takes energy normally wasted during braking and turns it into usable energy. It is not, however, a perpetual motion machine. Energy is still lost through friction with the road surface and other drains on the system. The energy collected during braking does not restore all the energy lost during driving but it improve energy efficiency helps the main alternator.

This is the other technology to be employed controls vehicle speed by converting a portion of its kinetic energy (energy of motion) into another useful form of energy. The energy so produced could then be stored as electric charge in the [automobile battery](#).



PROBLEM STATEMENT :

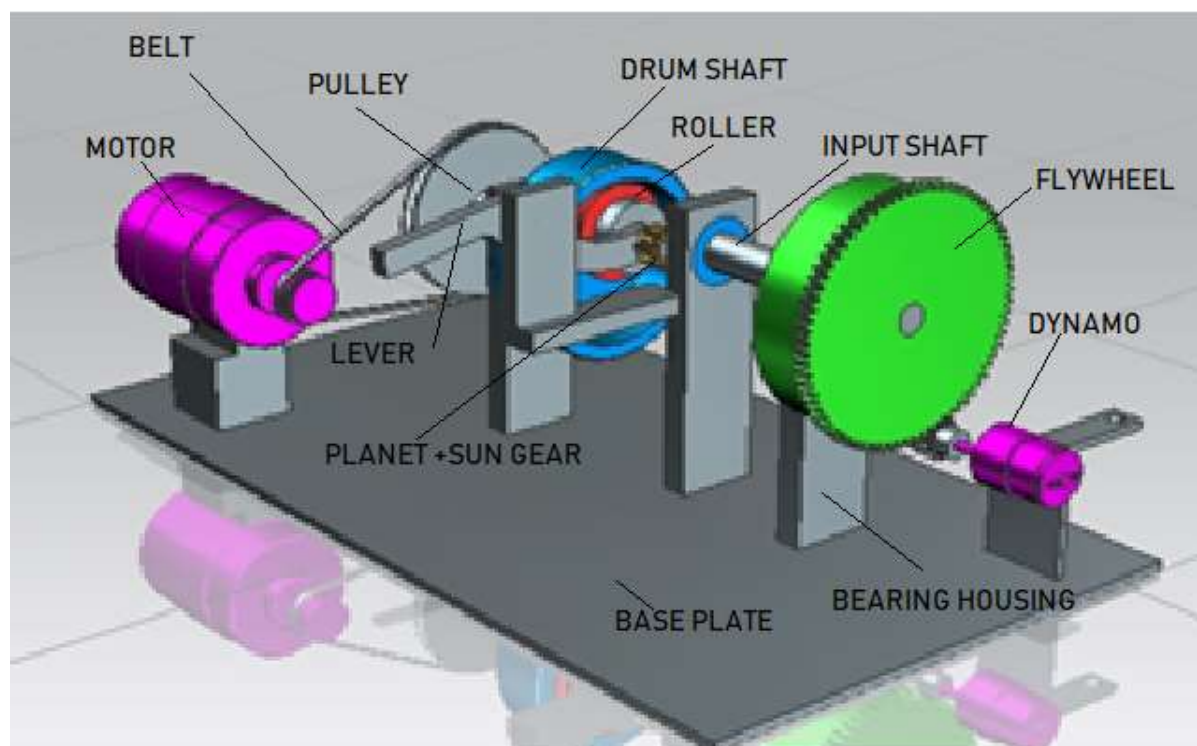
DISADVANTAGES OF EXISTING SYSTEMS (need for project) :

1. Existing systems aim at converting basically the momentum ($m \times v$) of the vehicle in to mechanical energywhich is further converted into electrical energy by dynamo to be stored into batteries....this energy stored in batteries is later reused to accelerate the vehicle using DC motor....there are bound to be conversion losses at each stage due to in-efficiency of each component of system –viz, the dynamo ---battery---and the electric motor.
2. The system components of the above discussed system are extremely costly ...thereby making implimentation of technology close to impossible.
3. Computers and electronic controls are absolutely essential to run the system, hence the running cost of such system is considerably high.

Hence there is need of a simpler system that will convert and store the momentum energy (kinetic energy) into electrical energy via a simple system that by reducing the conversion losses and keep the system production , installation and running cost to minimum.

SOLUTION TO PROBLEM :

The technology used in the single roller regenerative braking system –mechanical regeneration type is as follows



The system as shown above comprises of an electrical motor which is used as prime mover to the prototype. The motor is variable speed which permits to test the set up at various speeds. The motor drives the input drum shaft thus resembles the wheel drum hub of the vehicle by an open belt drive. The brake force is applied to the drum by means of the planet roller that is mounted on a floating pin with a spur pinion at its other end. The pin is mounted on lever which is hinged at its center. The brake lever when applied the friction roller comes in contact with the input drum and starts rotating, its rotary motion is transferred to the sun gear from the planet gear mounted on the planet roller pin. The sun gear is mounted on the main shaft which also carries the flywheel gear. The flywheel gear drives the pinion mounted on the generator. The motion of the flywheel is transferred to the generator and thus electricity is produced.

2. Literature review :

[1] As per Mr. Pulkit Gupta et al, the research work embodied a technology that saves energy from getting wasted by using regenerative braking systems (RBS). According to the when driving an automobile, a great amount of kinetic energy is wasted when brakes are applied, which then makes the start up fairly energy consuming thus a product that stores the energy which is normally lost during braking, and reuses it is necessary. The use of regenerative braking system in automobiles provides us the means to balance the kinetic energy of the vehicle to some extent which is lost during the process of braking. The authors in their paper have presented two different methods of using the kinetic energy which generally gets wasted by converting it into either mechanical energy or into electrical energy. Flywheel is used for converting the kinetic energy to mechanical energy other method uses Electric Motor to convert Kinetic Energy into electrical energy.

[2] As per Mr. GouYanan, To improve driving ability of electric vehicle, a braking regenerative energy recovery of electric vehicle was designed and the structure of it was introduced, the energy recovery efficiency of whole system was defined and a highly efficient control strategy was put forward, then it was embedded into the simulation of ADVISOR2002. The recovery efficiency of the system was up to 60%, the electric vehicle energy recovery efficiency was effectively improved.

[3] As per Mr. Siddharth K. Patil, here is a need of specific technology that recovers the energy, which gets usually wasted. So, in case of automobiles one of these useful technology is the regenerative braking system. Generally in automobiles

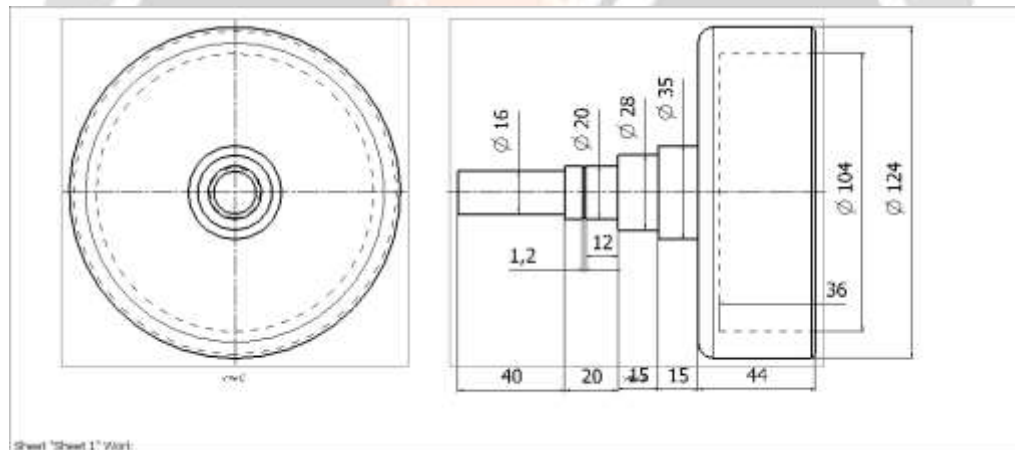
whenever the brakes are applied the vehicle comes to a halt and the kinetic energy gets wasted due to friction in the form of kinetic energy. Using regenerative braking system in automobiles enables us to recover the kinetic energy of the vehicle to some extent that is lost during the braking process. In this paper the author discusses two methods of utilising the kinetic energy that is usually wasted by converting it into either electrical energy or into mechanical energy. Regenerative braking system can convert the kinetic energy into electrical energy with help of electric motor. And it can also convert the kinetic energy into mechanical energy, which is supplied to the vehicle whenever it is needed, with the help of a flywheel.

[4] As per Mr. Olufemi 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

2.1 Literature Gap

From careful stud of the literature pertaining to the problem of energy recovery from the momentum of the vehicle that is wasted during the braking process , many methods are proposed , few including flywheels and some with motor generator combination, There is a need to develop a system that could use minimal space and take up minimum cost. The project aims at design development and analysis of one such system using a planet friction roller system

DESIGN OF INPUT DRUM SHAFT



Material of Input drum shaft allowable stress = 110 N/mm^2

$\Rightarrow T_{\text{design}} = 0.475 \text{ Nm}$

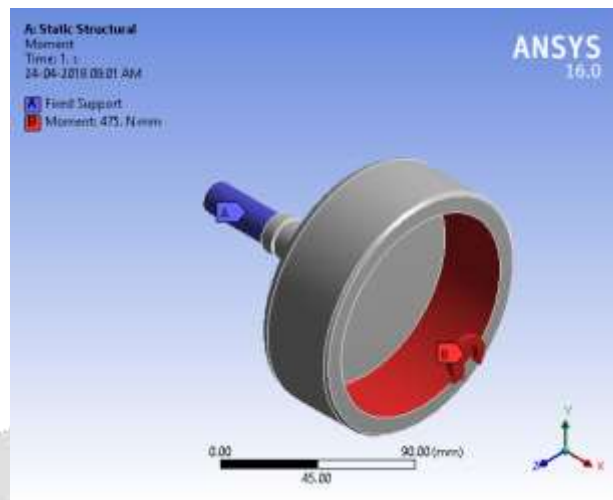
Maximum theoretical torsional stress ($f_{s_{\text{act}}}$) = 0.55 N/mm^2

As; $f_{s_{\text{act}}} < f_{s_{\text{all}}}$, Roller is safe under torsionl load.

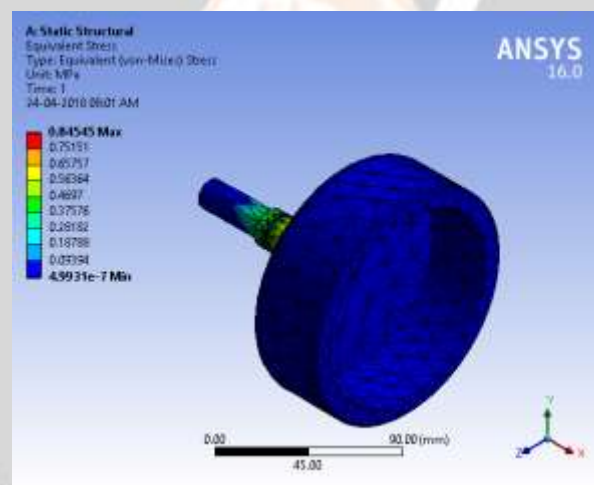
$f_{s_{\text{act}}} = 0.55 \text{ N/mm}^2$

As; $f_{s_{\text{act}}} < f_{s_{\text{all}}}$

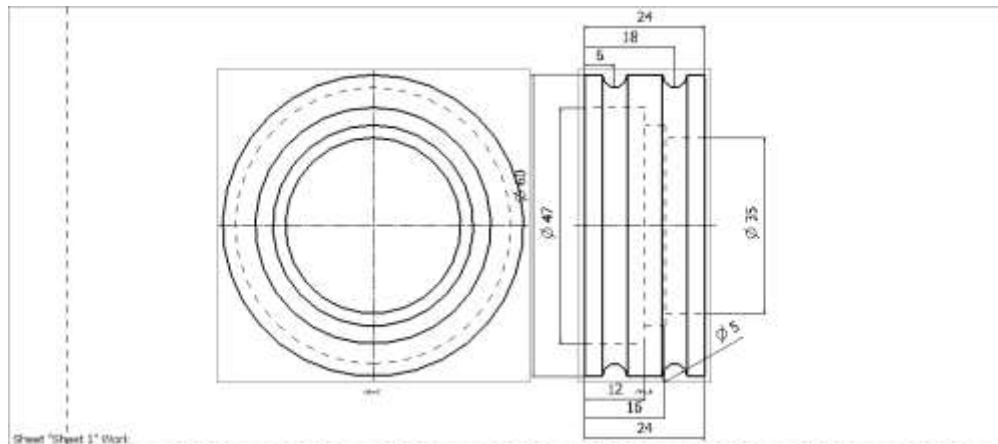
Input drum shaft is safe under torsional load

ANALYSIS OF DRUM SHAFT:

Maximum turning moment applied = 475 N-mm .



As the induced stress is well below the permissible limit the part is safe.

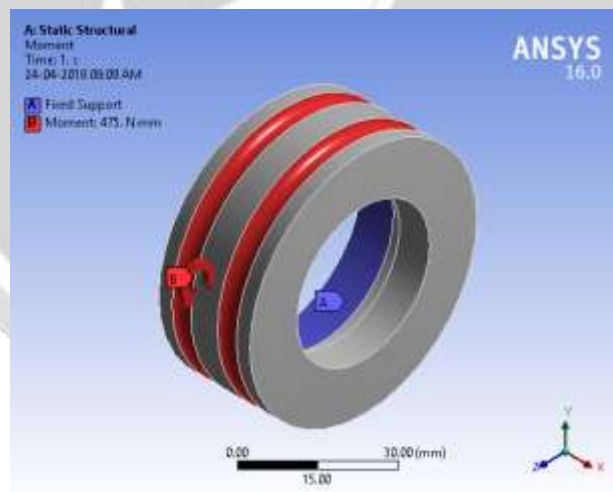
DESIGN OF ROLLER :

Material of Roller EN9 allowable stress $= 90 \text{ N/mm}^2$

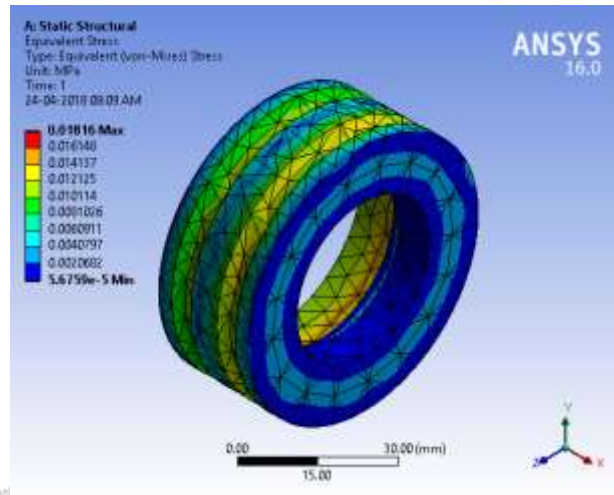
$\Rightarrow T_{\text{design}} = 0.475 \text{ Nm}$

Maximum theoretical torsional stress ($f_{s_{\text{act}}}$) $= 0.06 \text{ N/mm}^2$

As; $f_{s_{\text{act}}} < f_{s_{\text{all}}}$, Roller is safe under torsionl load.

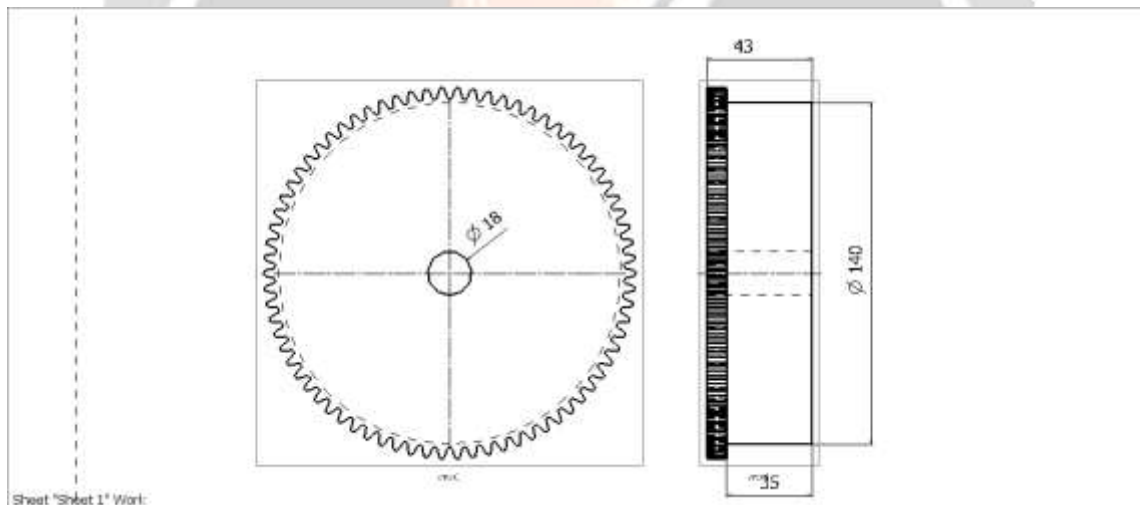
ANALYSIS OF ROLLER :

Moment applied = 475 N-mm



As the induced stress is well below the permissible limit the part is safe

DESIGN AND ANALYSIS OF FLYWHEEL

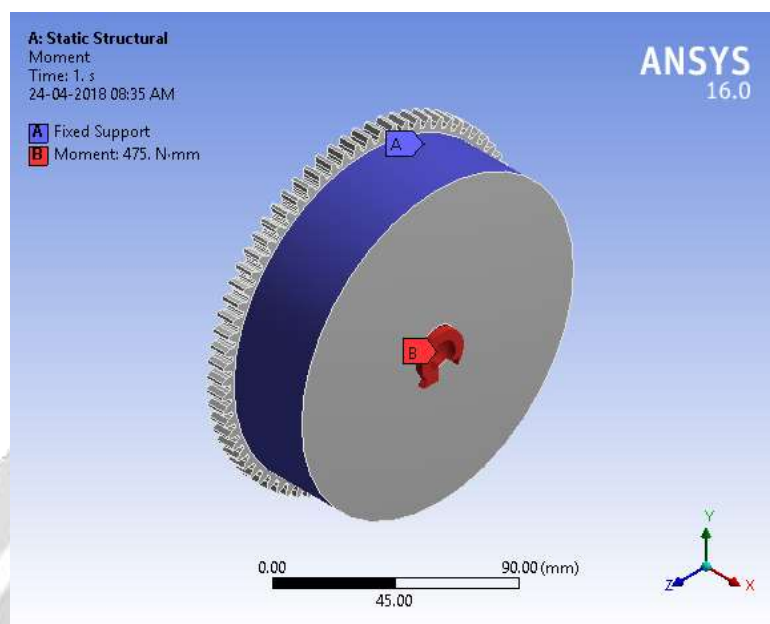


Material of Roller EN9 allowable stress = 90 N/mm^2

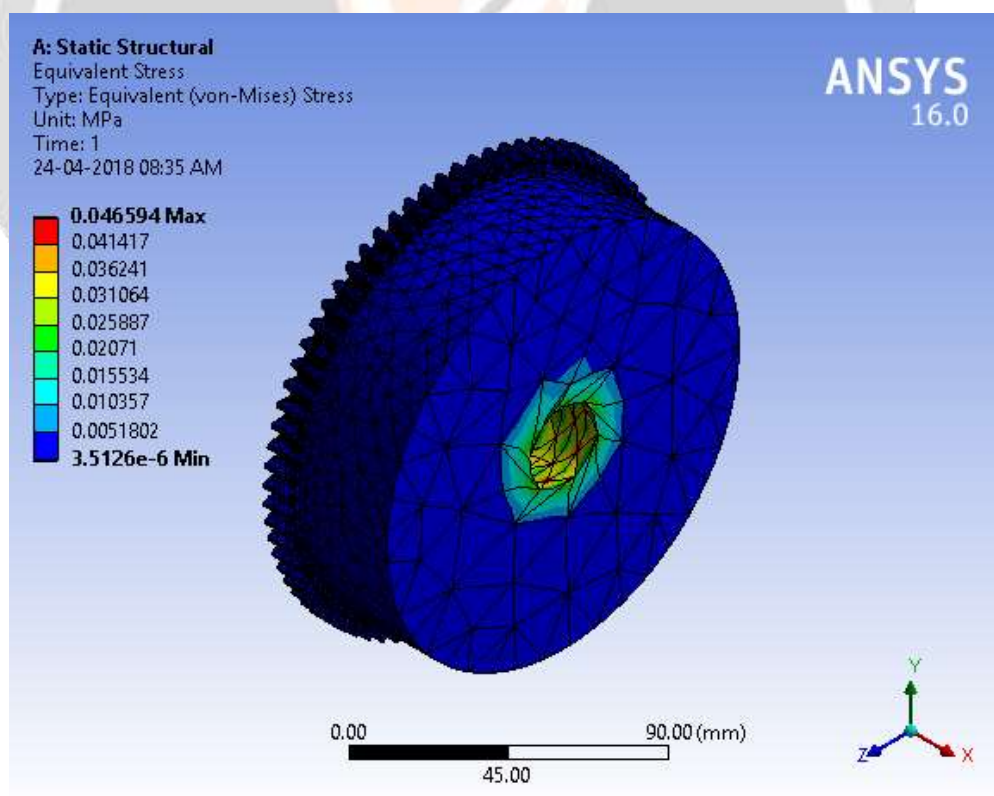
$\Rightarrow T_{\text{design}} = 0.475 \text{ Nm}$

Maximum theoretical torsional stress ($f_{s_{\text{act}}}$) = 0.01 N/mm^2

As; $f_{s_{\text{act}}} < f_{s_{\text{all}}}$, Flywheel is safe under torsionl load.

Analysis of flywheel :

Maximum Turning moment applied is 475 N-mm



As the induced stress is well below the permissible limit the part is safe

4. CONCLUSIONS

After careful review of literature it was found that no specific solution to problem of energy recovery from the momentum of the vehicle that is wasted during the braking process, many methods are proposed, few including flywheels and some with motor generator combination, There is a need to develop a system that could use minimal space and take up minimum cost.

An innovative solution is proposed to the problems and all critical parts of the system have been designed and analysis of the same has proven the parts to be safe.

5. ACKNOWLEDGEMENT

In the due course of project with the valuable guidance of Guide. Prof. xxxxxxxr. the project was completed as per schedule and desirable results were achieved.

6. REFERENCES

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