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RESEARCH ARTICLE OPEN ACCESS

Structural Analysis of Regenerative Braking System

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Abstract:

Regenerative braking system is a system for recovering the moving vehicle's kinetic energy under braking load 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. Present day regenerative braking systems make use of motor-generator setup for this purpose. 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 an 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 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.

Keywords — **Regenerative Braking System, Drum, Roller, Structural analysis.**

I. INTRODUCTION

When a conventional vehicle applies its brakes, kinetic energy is converted to heat as friction between the brake pads and wheels. This heat is carries away in the airstream and the energy is effectively wasted. The total amount of energy lost in this way depends on how often, how hard and for how long the brakes are applied. Regenerative braking refers to a process in which a portion of the kinetic energy of the vehicle is stored by a short-term storage system. Energy normally dissipated in the brakes is directed by a power transmission system to the energy store during deceleration. That energy is held until required again by the vehicle, whereby it is converted back into kinetic energy and used to accelerate the vehicle.

The magnitude of the portion available for energy storage varies according to the type of storage, drive train efficiency, drive cycle and inertia weight. A lorry on the mom way could travel 100 miles between stops. This represents little saving even if the efficiency of the system is 100%. City center driving involves many more braking events representing a much higher energy loss with greater potential savings. With buses, taxis, delivery vans and so on there is even more potential for economy. Since regenerative braking results in an increase in energy output for a given energy input to a vehicle, the efficiency is improved. The amount of work done by the engine of the vehicle is reduced, in turn reducing the amount of prime energy required to propel the vehicle. For a regenerative braking system to be cost effective the prime energy saved over a specified lifetime must offset the initial cost, size, and weight penalties of the system. The energy storage unit must be compact, durable, and capable of handling high power levels efficiently, and any auxiliary energy transfer or energy conversion equipment must be efficient, compact and of reasonable cost.

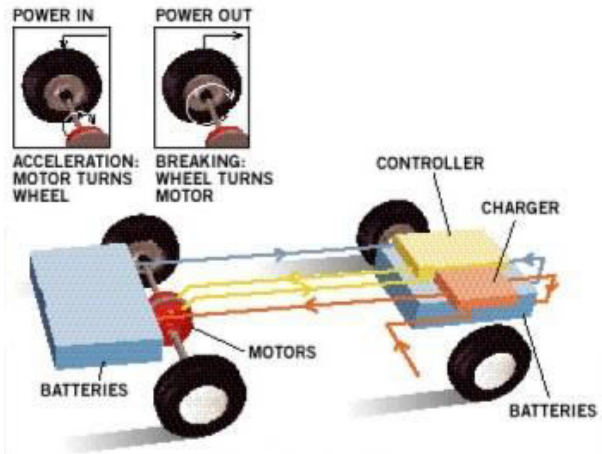

Fig. 1 Working of Regenerative Braking System

II. LITERAURE SURVEY

[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. Gou Yanan, 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.

III. DIMENSIONS OF BRAKE DRUM AND ROLLER

A. Components:

The major components of the braking system are drum and the roller. Drum is a part of Braking system where it gives energy to the Roller to generate energy. It is size of wheel of an Automobile in dimension. Materials used alloys of steel and aluminum. Roller is a part of regenerative system which takes energy from Drum after applying Brakes. Mostly, it is 1/3 of the Drum in dimensional wise. Materials used alloys of steel and aluminum. Vehicles driven by electric motors use the motor as a generator when using regenerative braking. It is operated as a generator during braking and its input and its output is supplied to an electrical load. The transfer of energy to the load provides the braking effect. Many modern hybrid and electric vehicles use this technique to extend the range of battery pack.

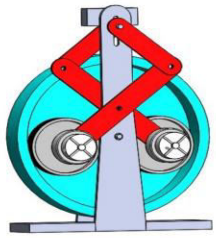

Fig. 2 Block diagram of regenerative braking

B. Dimensions of Brake Drum:

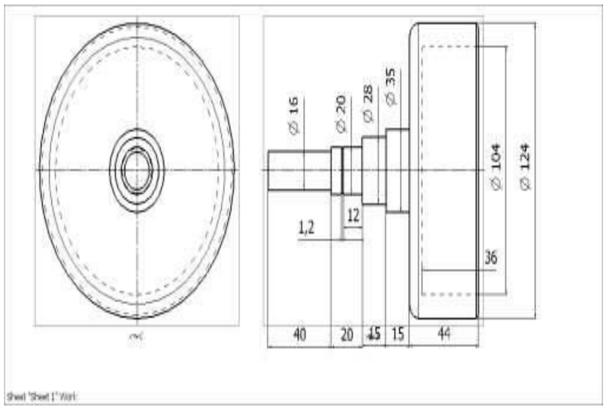

Fig. 3 Dimensions of Drum

TABLE I
DIMENSIONS OF DRUM

S.NO	DESCRIPTION	DIMENSIONS (mm)
1	Braking Section Diameter	124
2	Internal Diameter	104
3	Centering Bore Diameter	35
4	Flange Thickness	8
5	Height Between Backing Plane and Higher Plane	44

C. Dimensions of Roller:

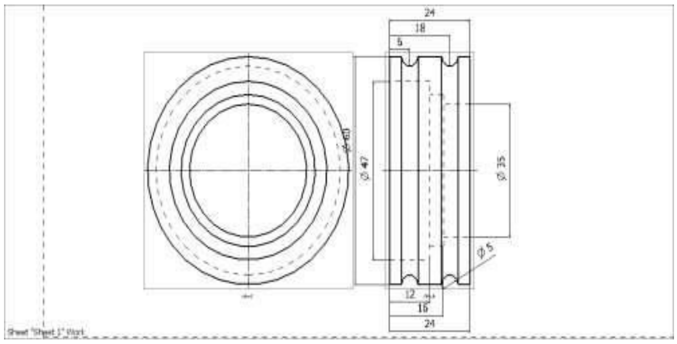

Fig. 4 Dimensions of Roller

TABLE II
DIMENSIONS OF ROLLER

S.NO	DESCRIPTION	DIMENSIONS(MM)
1	Outer Diameter	60
2	Inner Diameter 1	47
3	Inner Diameter 2	35
4	Depth of Notches	5
5	Roller Width	24

IV. DESIGN AND ANALYSIS OF COMPONENTS:

A. Design and Analysis of Drum

Drum is one of the major components in regenerative braking system. It gives energy to the roller to generate energy.

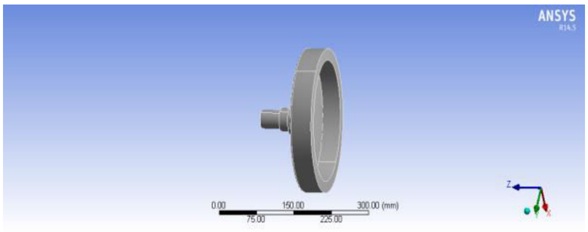

Fig. 5 3D model of Drum

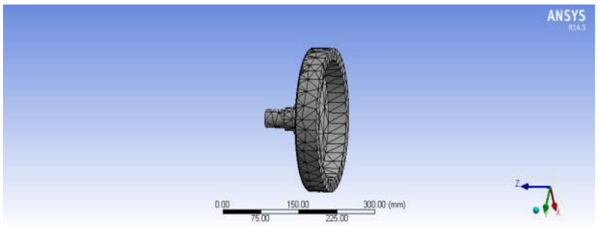

Fig 6: Meshed model of Drum

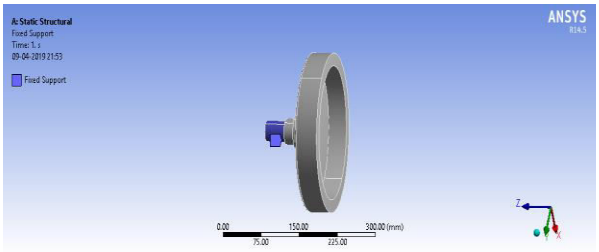

Fig 7: 3D Model of Drum with Fixed Support

B. Equivalent stress applied on Drum

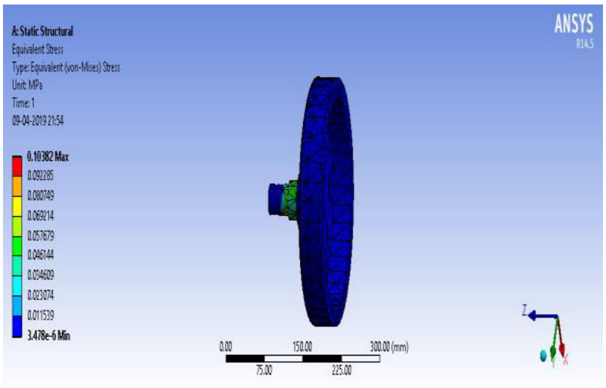

Fig 8: Equivalent stress applying on Drum

C. Total deformation after applying moment and equivalent stress

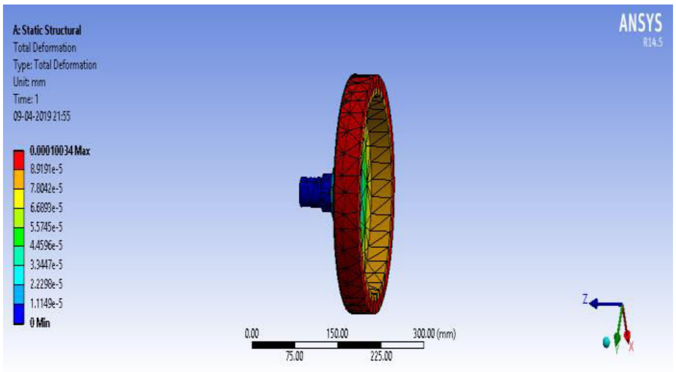

Fig 9: 3D Model of Drum after Total Deformation

From the Fig 8 and Fig 9 stresses and deformation for drum are 0.10382 Mpa,0.00010034 mm.

D. Design and Analysis of Roller

Roller is a component of regenerative braking system which takes energy from drum shaft.

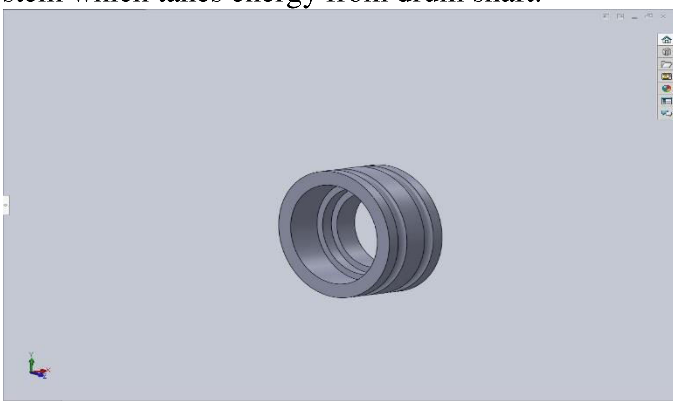

Fig10: Design of 3D Model of Roller

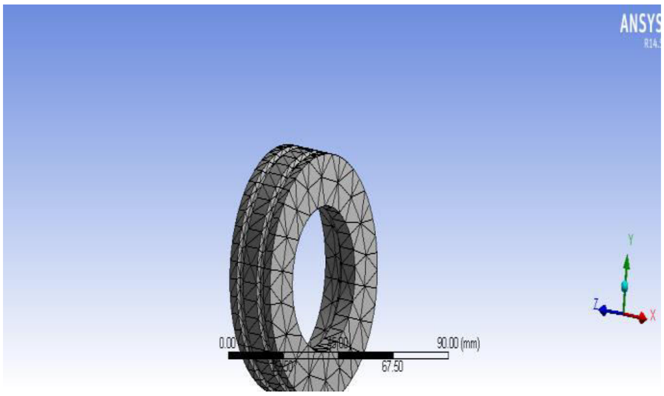

Fig 11: Meshed model of Roller

E. Equivalent stress applied on Roller

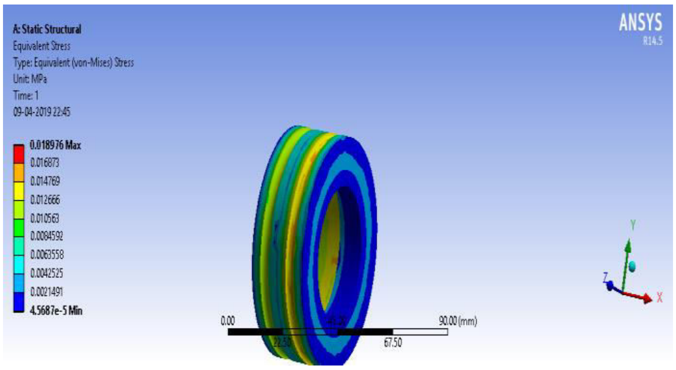

Fig 12: Equivalent stress applying on Roller

F. Total deformation after applying moment and equivalent stress

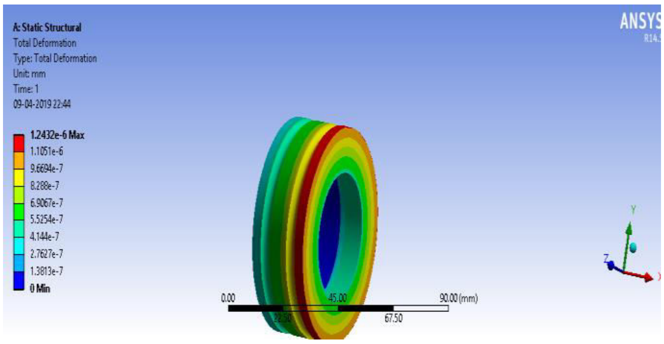

Fig 13: 3D Model of Roller after Total Deformation

From the Fig 12 and Fig 13 stresses and deformation for drum are 0.01876 Mpa,1.2432e-6 mm.

V. RE-DESIGNED COMPONENTS

A) Re-Designed Drum

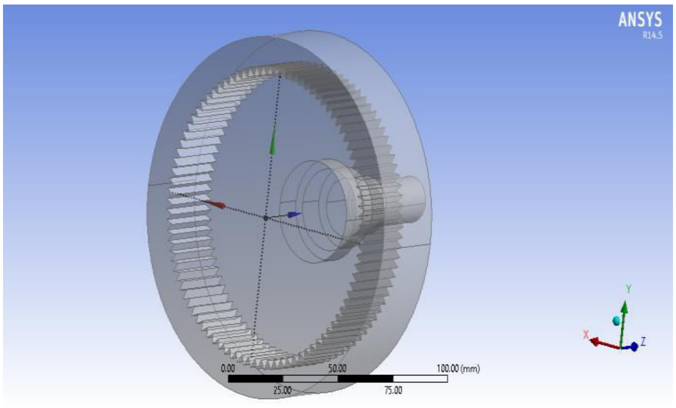

Fig 14: Re-Designed Drum

TABLE III
DIMENSIONS OF RE-DESIGNED DRUM

S.NO	Description	Dimensions(mm)
1	Inside Diameter	51.8826
2	Internal Base Circle Diameter	48.75
3	Pitch	3.57677
4	Pitch Diameter	50.316326

B) Re-Designed Roller

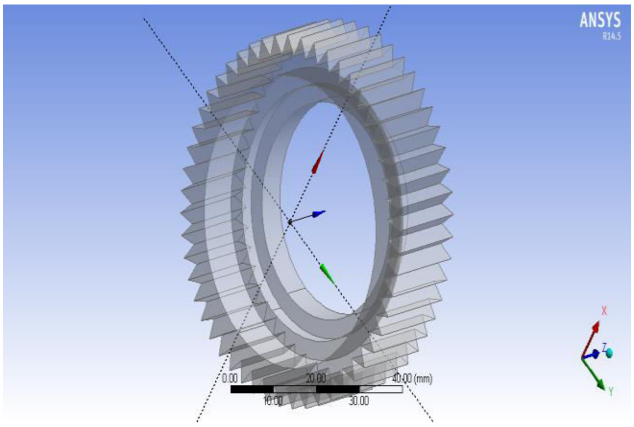

Fig 15: Re-Designed Roller

TABLE IV
DIMENSIONS OF RE-DESIGNED ROLLER

S.NO	Description	Dimensions(mm)
1	Outside Diameter	29.935196
2	Outside Base Circle Diameter	26.75
3	Pitch	3.61488
4	Pitch Diameter	28.342598

VI. DESIGN AND ANALYSIS OF RE-DESIGNED COMPONENTS

A) Design and Analysis of Re-designed Drum

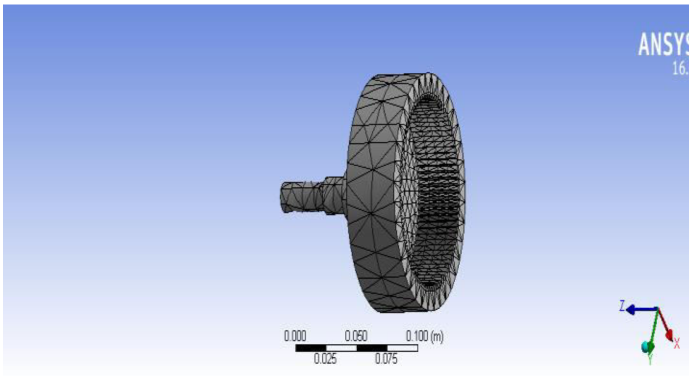

Fig 16: Meshed model of Redesigned Drum

B) Equivalent stress applied on Re-designed drum

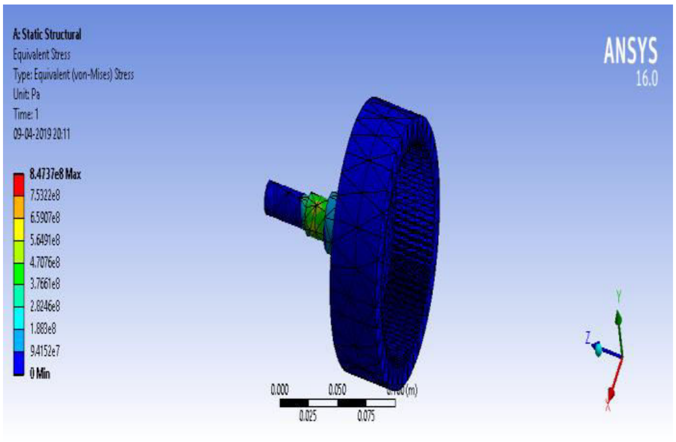

Fig 17: Equivalent Stress applying on Drum

C) Total deformation after applying moment and equivalent stress

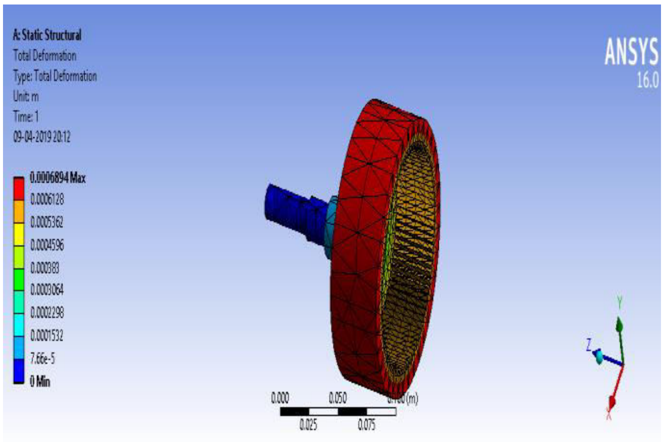

Fig 18: 3D Model of Drum after Total deformation

From the Fig 17 and Fig 18 stresses and deformation for drum are 8.48e8 Mpa,0.0006894 mm.

D) Design and Analysis of Re-Designed Roller

Fig 19: Meshed model of Redesigned Roller

E) Equivalent stress applied on Re-Designed Roller

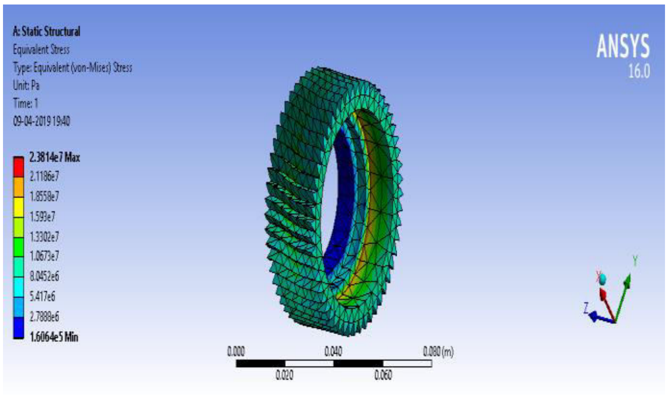

Fig 20: Equivalent Stress Applying on Redesigned Roller

F) Total Deformation after applying moment and equivalent stress

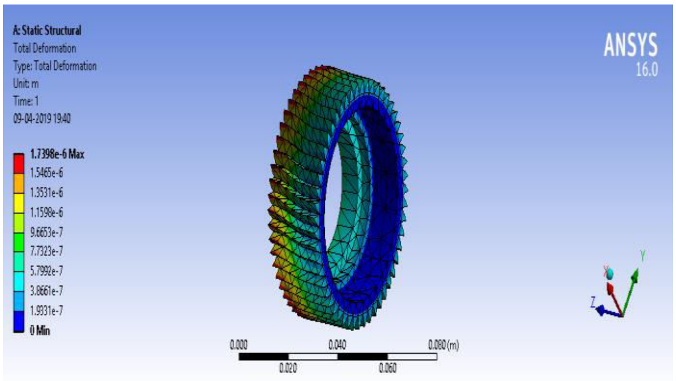

Fig 21: 3D Model of Redesigned Roller after Total Deformation

From the Fig 20 and Fig 21 stresses and deformation for drum are 2.38e7 Mpa,1.73e-6 mm.

VII. RESULT

This analysis shows that the stresses in the redesigned Drum are a bit higher compared to the Traditional Drum and the stresses in the redesigned Roller are nearly equal to the Traditional one, which shows that the Life period of the Drum might get decreased due to higher stresses where the Roller will not get affected by Life period due to less stresses. This shows that the Efficiency will get increased due to grip in the gearing mechanism, where stresses will not affect the Efficiency. As our main goal is to Increase the Efficiency.

VIII. CONCLUSIONS

To decrease the slip in the Braking system, we have introduced Gearing instead of the plane lining between the Drum and the Roller. As the stresses are lightly higher in the Gearing mechanism compared to the traditional Roller and Drum arrangement, the life period of the gearing might be decreased compared to the Traditional mechanism. So, we have possibilities of using different types of gears instead of V gears, which have higher contact area so that stresses may get decreased which reflects on the life period of the Mechanism. As we believe that Stresses induced in the Gearing will not affect the efficiency rather gearing increases the efficiency by bringing back the efficiency lost due to slip in the Traditional mechanism. Using suitable materials can improve the life of the Mechanism.

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