Shockless Power Generation: an Alternative Energy Source

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Abstract- **With advent of technology we are trying to develop devices which not only a boon to the existing resources but rather a non renewable energy based technology. This paper defines a technique and gives an idea for generating energy from the vehicle traveling on the road. A brief description about the project is illustrated with help of mechanical design, general concept and configuration. This paper describes the principle of plate sliding on track due to the movement of vehicles on the plates installed over the roads ,this system is basically installed over highways and expressways, where road is the basic means of transportation. This technology harnesses the basic concept of vehicle passing on the highways. Whenever a vehicle moves from this arrangement, the tire comes in contact with the sliding plate and hence the friction between them comes into the play and tries to move the moving plate from its initial position. This device converts the kinetic energy of the vehicles into electric energy by installing moving plate on the road. With, the testing result, it has been shown that a minimum 20km/hr speed is required to initiate the process with about 2000 frequency when only one link is attached with the plate, that means most of vehicles passing over this arrangement can be fully harnessed to produce the energy. On the practical side we have been able to produce and store the energy with minimum speed of 20km/hr, and the system is considerably simple to install, inexpensive compared with other resources, safe and more importantly does not pollute the environment i.e. eco-friendly. This system can be further modified and further can be subjected for upgrading. This technology is the boon for rural, as well as for urban regions to satisfy the ever increasing demand and that to at a very feasible cost.**

Keywords- **Harvesting, non-renewable energy, moving plate, friction, kinetic energy.**

1. Introduction

India is very vast country and due to over excess of population its need tremendous amount of energy sources for daily purpose. In world, energy are mainly produced from non-renewable energy sources like coal, fossil fuel, natural gas etc. and in India coal is the major source for energy generation for various sector. But the disadvantages of non-renewable energy sources are they made up of carbon atoms which emits large amount of carbon dioxide due to carbon content in atmosphere. Due to this today world is facing the problem of ozone layer depletion which results in acid rain. In times, as now when world is moving towards an impending energy crisis, promoting energy conservation plan is a must On this background we try to seek the attention of decision maker on the government to move towards the renewable energy. Our research is about generating electricity from moving vehicle on the highways and storing it in storable devices and further the electricity is utilized for street light, battery charging station for electric cars. Thus our device help to generate electricity without effecting the environment surrounded to us.

Why Shock less Road Power generation?

In shock less road power generation device "**Shock Less**" term implies that this device is a shock less means free of impact on vehicle due to Sliding Plates. There are several methods to generate the electricity by using road and speed breaker system. But those devices creates jerk and effects efficiency of vehicles.

2. Literature Review

Many researchers have been conducted on renewable energy sources and the most available studies are Alexander Zeh et al [1] prepared strategies to operation of power grid and battery during summer season. Ana Vincent et al [3] carried out an experiment making hybrid power generation system through photovoltaic and diesel simulation. Dongmin Xi et al [5] shows the basic equipment need for the power generation and supply with grid and ac distribution for renewable energy resources system. Franco Cotana et al [7] they established a renewable energy production, storage and distribution in the rural areas. The study made by Jafor Antoun et al [9] over the vehicles tire pressure and their impact over the road and how the speed and pressure can now be utilized for power generation. The study over the novel acoustic wave equation the cavities in the car tyres. Mustapha Elamouri et al [15] this paper enlighten on the further advanced improvement in the field of wind energy generation at low speed with the help of

maximum energy principle and Weibull Model. The significant study made by M J Gagen et al [16] for the tire behaviour during different pressure density of air filled. M. Ravichandran et al [17] explains how vehicle moving on road produces energy from waste kinetic energy of the vehicle by utilizing the breaker system. Jian Wang et al [19] carried out a control strategies for distributed power generation system from the dc generator and regulate the voltage by using flywheel storage system. Ozgur Demirtas et al [21] carried out possibility of generation of renewable energy and problem faced in the Turkey. Shakti Singh et al [24] proposed a plan for self-energy generation using solar and bio mass using hybrid system. The waste kinetic energy from vehicles and convert it in to electricity using roller attached on the road is the basic concept given by Wail Adaileh et al [27]

An idea has been developed in which we try to utilize the maximum wasted energy and try to eliminated the usage of non-renewable resources comes with the Shock less Road Power Generation. This device is engineered as a practical and useful alternative energy technology for generating clean electricity from the millions of vehicles on our roadways.

3. Construction and Working

In Shock Less Road Power Generation system a friction sliding plate is used to get deflection by means of friction between vehicle's tire and the plate. The device shock less road power generation system is installed on the road with sufficient ground clearance and with minimum installation over road. This device consists of a sliding plate, two link arrangements, DC motor and generation device which include battery, rectifier and one way circuit for charging system.

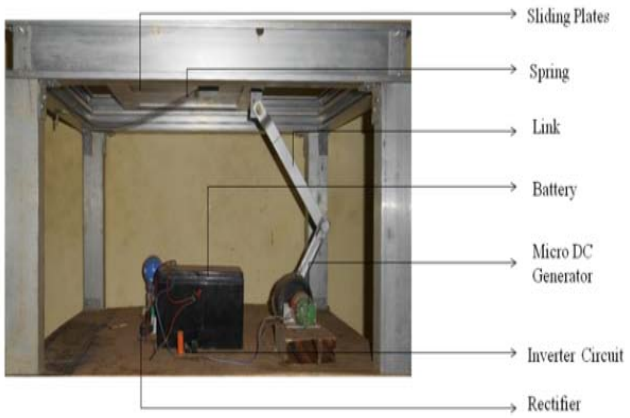


Fig 1:- Model of Shock Less Road Power Generation

In this device two links are connected with a slider and with a DC motor by the help of three turning pair. In this device we utilize the generated friction force between sliding plate and tire of vehicle for deflection of plates. Hence this generated friction force will act in form of work. When the vehicle passes over this device then plate will deflect in Simple harmonic manner and this sliding plate is connected to link arrangements. Hence with the deflection of this sliding plate links are also deflected in simple harmonic manner, and this links are connected to DC motor which results in generation of direct current. This generated direct current utilized in generation device to charge the battery. Here we utilized rectifier to get constant voltage and one way circuit is used to store the generated electrical energy in only in the direction of charging the battery or electrical energy storage device.

4. Design Calculation

Before the system test, it is necessary to examine the proposed design from the strength point of view in order to validate its safe to work under variable load. Table 1 shows all elements of the system, properties of materials, selection of proper material and the manufacturing process on each item, the numerical example illustrated the results for system strength and the load that can be used.[27]By testing the system using a vehicle type Tata truck in the automotive manual workshop at two speeds, the results of test are as below.

The vehicle with the following specifications:-

$$M_{Total} = 15 \times 10^3 kg$$

Where M_{Total} = the total mass of the vehicle in kg.

T = 1550 Nm (from the vehicle manual), Where T= Maximum engine torque.

$$e_o = e_G \times e_{axle}$$

Table 1:- Material used in Shock less Road Power Generation

SR. NO.	COMPONENTS	MATERIAL	MATERIAL PROPERTIES	SELECTION FOR PROPER MATERIAL	MANUFACT-URING PROCESS
I.	Frame	Steel AISI1020	High tensile and compressive strength	Cost, Width of Vehicle, Weight, Height	Cutting, Welding, Facing
II.	Sliding plate	Steel AISI1020	High compressive strength	Cost, Weight	Knurling, Cutting
III.	Bell crank link	Steel AISI1020	Rigid nature	Cost, Weight	Milling
IV.	Bearing	-	Proper relative motion	Cost, Availability,	Rolling
V.	Spring	-	Proper fluctuation	Cost, Availability, Load	Rolling
VI.	Generator	-	As per required	Cost, Availability	-
VII.	Base	Alloy steel/ leather	Holding stress	Load	Drilling, Welding, Cutting

$$e_o = 5 \times 4 = 20$$

Where, e_o = the overall speed ratio in the driving axle;

e_G = Speed ratio in the gear = 5

e_{axle} = Speed ratio in the driver axle = 4 (vehicle manual).

The tire radius: r = 0.51 m (vehicle manual);

The mechanical efficiency, n_{mech} = 90% (vehicle manual);

The driving axis carries 2/3 of total mass;

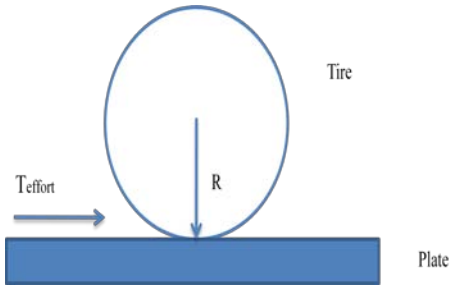
The coefficient of friction between the tire and the road surface, f = 0.7.

The load transmitted to driving axis:-

$$W = \frac{2}{3} \times 11 \times 10^3 \times 9.81$$

W= 71940 N.

The tractive force (effort) at the contact point is shown in figure below



$$T_{EFFORT} = \frac{T_{ENGINE} \times e_o \times n_{mech}}{r}$$

$$T_e = \frac{1550 \times 20 \times .90}{.51}$$

$$T_e = 54705.88 \text{ N.}$$

$$T_e = 55 \text{ KN (approx).}$$

Calculation of forces on plate:-

Taking factor of safety =2.

The plate is subjected to bending load of 110 KN in X-Y plane and tangential load of 55 KN in X-Z plane. Figure 2 shows the shear force and bending moment diagram in XY plane, It is clearly seen that in XY plane the shear force acting is 55 KN and maximum bending moment is 21.06 KN-m.

Figure 3 shows the shear force and bending moment diagram in XZ plane, From figure it is clear that the tangentional load acting on system is 55KN and due to it shear force acting is 27.5KN and maximum bending moment is 10.31KN-m.

$$R_{A(total)} = \sqrt{55^2 + 27.5^2}$$

$$R_{A(total)} = 61.49\ KN.$$

$$R_{B(total)} = \sqrt{55^2 + 27.5^2}$$

$$R_{B(total)} = 61.49\ KN.$$

The total Moment acting on plate:-

$$M_{total} = \sqrt{M^2{}_A + M^2{}_B}$$

$$M_{total} = \sqrt{10.3125^2 + 20.625^2}$$

M_{total} =23.06 KN-m.

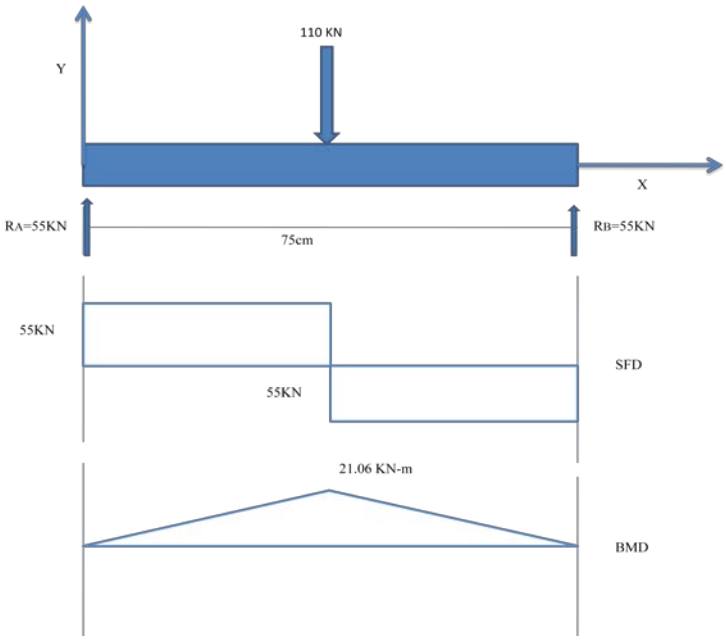


Figure 2:- shows the shear force and bending moment diagram in XY plane

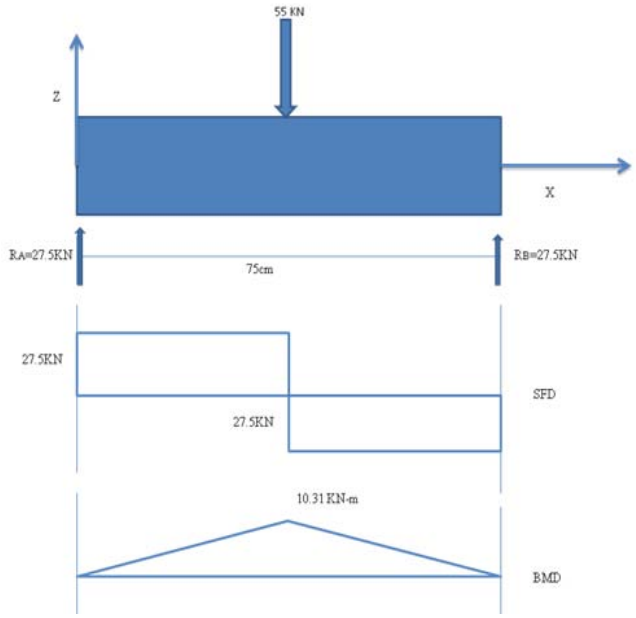


Figure 3:- shows the shear force and bending moment diagram in XZ plane

Calculation of stresses acting over plate:-When the plate subjected to bending stress:-

$$\sigma_{bending} = \frac{My}{I}$$

Where M= Bending Moment

y= Distance from Neutral Axis

I= Moment of Inertia

$$I = \frac{bh^3}{12}$$

$$I = \frac{0.75 \times .05^3}{12}$$

Where b= Width of Plate

h= Height of Plate

$$I = 7.8125 \times 10^{-6}\ m^4$$

$$\sigma_{bending} = \frac{23060.392 \times .375}{7.7125 \times 10^{-6}}$$

$$\sigma_{bending} = 73.79\ MPa$$

When Plate is subject to shear stress:-

$$\tau_{xy} = \frac{\text{Shear Force}}{\text{Shear Area}}$$

$$\tau_{xy} = \frac{55 \times 10^3}{0.75 \times 0.25}$$

$$\tau_{xy} = 0.293\ MPa$$

Strength Calculation: - Material of the plate is Steel AISI 1020 HR

So we have

$$S_{yt} = 210MPa$$

$$S_{ut} = 380MPa$$

$$\sigma_x = 73.79\ Mpa,$$

$$\sigma_y = 0, \qquad \tau_{xy} = 0.293\ MPa$$

$$\sigma_1 = \frac{\sigma_x + \sigma_y}{2} + \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + {\tau_{xy}}^2}$$

$$\sigma_1 = \frac{73.79 + 0}{2} + \sqrt{\left(\frac{73.79 - 0}{2}\right)^2 + 0.239^2}$$

$$\sigma_1 = 73.79\ MPa$$

$$\sigma_2 = \frac{\sigma_x + \sigma_y}{2} - \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + {\tau_{xy}}^2}$$

$$\sigma_2 = \frac{73.79 + 0}{2} - \sqrt{\left(\frac{73.79 - 0}{2}\right)^2 + 0.239^2}$$

$$\sigma_2 = -1.163 \times 10^{-3} MPa$$

According to Von Misses theory for bi-axial stresses

$$\frac{S_{yt}}{(fs)} \geq \sqrt{(\sigma_1^2 - \sigma_2^2) + (\sigma_2^2 - \sigma_3^2) + (\sigma_3^2 - \sigma_1^2)}$$

Where $\sigma_3 = 0$

$$\frac{S_{yt}}{(fs)} \geq \sqrt{(\sigma_1^2 - \sigma_1\sigma_2 + \sigma_2^2)}$$

$$\geq \sqrt{73.79^2 - 73.79 \times (-1.163 \times 10^{-3}) + (-1.163 \times 10^{-3})}$$

$$\frac{S_{yt}}{(fs)} \geq 73.79MPa$$

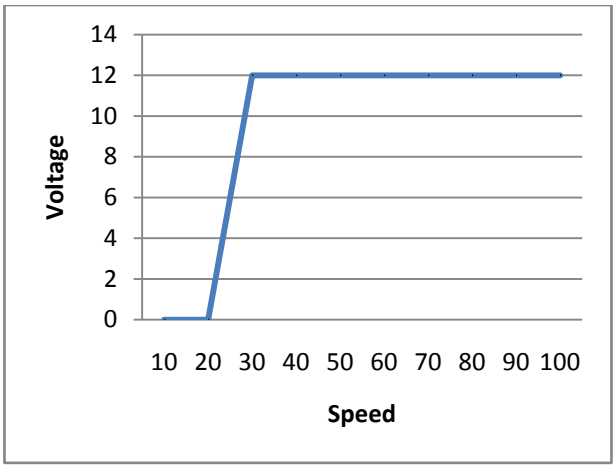
Since for Material Steel AISI 1020 HR we have

$$\frac{S_{yt}}{(fs)} = 105MPa$$

This value is well above our design value so our design is safe. So there is no possibility of failure of system during load or yielding.

5. Conclusion

In this paper we focused on the waste kinetic energy. When vehicle move on the moving plate, the tires comes in contact and try to move the moving plate from its initial position and thus converts the kinetic energy of the vehicles into electric energy. A minimum 20km/hr speed is required to start the system for charging. About 2000 frequency is required for single link attached with the moving plate to fully charge up the battery. The maximum number of vehicles passing on this device can be fully harnessed to produce the energy.



In the future there will be a large number of small generators connected to the distribution networks, small systems that can be combined with management and storage energy systems in order to improve the operation of distribution systems. For the environment aspect, this device considerably cleans, eco-friendly, sustainable and reliable. The total cost of system design, testing and installment reach up to 45000/- Rupees which not too much for long term use.

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