

## Research Article

## Design and Fabrication of Power generation System using Speed Breaker

D.Venkata Rao<sup>Å\*</sup>, K.Prasada Rao<sup>Å</sup>, S.Chiranjeeva Rao<sup>Å</sup> and R.Umamaheswara Rao<sup>Å</sup><sup>Å</sup>Department of Mechanical Engineering, GMRIT, Rajam-India-532127

Accepted 10 June 2014, Available online 01 Aug 2014, Vol.4, No.4 (Aug 2014)

### Abstract

In the present day scenario the fossil fuel sources are fast depleting and their combustion products are causing global environmental problems. So it is inevitable to shift towards the use of renewable energy resources which in turn will reduce pollution and saves fossil fuels. For meeting the regular demand of the energy we need to design a system such that electricity can be produced without destroying the nature. Road power generation is an alternative technology which uses the pressure due to the weight of vehicles for generation of power. Our project attempts to show how energy can be tapped and used at a commonly used system, the road speed breakers. The number of vehicles passing over the speed breaker on the roads is increasing day by day. There is possibility of tapping the energy and generating power by making the speed breaker as a power generation unit. The generated power can be used to light up nearby street lights. In the present work, a working model of the power generation unit is made. A similar model of the system has also been modeled in Pro-E. Design of each component is carried out using standard procedures. The components are fabricated and are finally assembled. The linear motion of the lever is converted into rotary motion using a crank shaft. The speed obtained is in turn amplified by using a set of gears. This amplified speed is used to run a generator to produce power. Theoretical calculations of power and the practical power obtained are compared in order to find the efficiency of the power generation unit. The utilization of energy is an indication of growth of a nation. This work utilizes one of the best sources of energy we get in our day to day life.

**Keywords:** power generation, energy conservation, speed breaker, connecting rod and Crankshaft.

### 1. Introduction

For reduction of carbon dioxide emission, renewable energies are considered as proper alternative energy (Selvaraj,R.S and Sivamadhavi.V. 2010). Renewable energies mainly refer to the wind, solar, biomass and marine currents which are less harmful to environment, attracting a wide attention of researchers in design and development of renewable energy conversion systems. Although improvement of renewable energy converters is in a fast rate, the systems to extract the wasted energy in conventional energy conversion systems are not developed as much as its technologies. In many systems and processes, dissipation of energy is inevitable whatever renewable or conventional energy was used. For instance, as a car passes over a speed-breaker, most of car kinetic energy will be wasted as heat in it. On other hand, to ensure the security of the populated areas of streets, the speed-breakers are required, whatever we used electrical cars or the cars consuming gasoil. There are numerous similar cases which such vast energies are wasting. Like an elevator during going down, a car during going down on a sloppy street, where regardless the used type of energy or efficiency of systems energy is systematically wasting. It is mainly due to condition that the systems are

operation in it. In this paper, we focus on the fixed speed-breaker at the streets since a high amount of vehicles kinetic energy is wasting there. There are thousands of crowded cities with enormous flow of vehicles offers high amount of energy can be considered as near to urban resource of energy. Also, extraction of such energy allows eliminating of transmission system between the remote areas and urban area for lightings purposes. There is a little literature about extraction of kinetic energy from flow of vehicle in the streets. There is so little and invalid literatures in generation of electricity by speed breakers that but the most common approaches can be seen in (Shakun Srivastava et al, 2011; Mukherje, D et al, 2005) these proposed systems, mostly small radial flux generators with ineffective topologies have been employed. Therefore it is necessary to design a suitable and efficient topology for design of an energy conversion system for extraction of kinetic energy of vehicles. This paper presents a novel speed-breaker generator (SBG) for extraction of kinetic energy of vehicle flow in the street. This device converts the kinetic energy of the vehicles into electric energy. This is done by moving plate installed on the road, this plate take the stroke motion of the vehicles and convert it to the rotary motion by crank mechanism and it generates the electricity (Mukherje, D et al 2005; Sharma P.C, 2003). The energy crisis is a great bottleneck in the supply of energy resources to an

\*Corresponding author: D.Venkata Rao

economy. The studies to sort out the energy crisis led to the idea of generating power using speed breaker. Firstly South African electrical crisis has made them implemented this method to light up small villages of the highway. The idea of basic physics to convert the kinetic energy into electrical energy that gone wasted when the vehicle run over the speed break (Watts 2004; Aswathaman.V and Priyadharshini.M 2010) explains clearly, the working principle of the designed system, its practical implementation, and its advantages. Design of each component has been carried out using standard procedures, and the components have been fabricated and assembled. A similar model of the system has been modeled using Pro-E. Practical testing of the system has been done with different loads at different speeds. Taking the various criteria that determine the power generation, graphs have been plotted. The utilization of energy is an indication of the growth of a nation. One might conclude that to be materially rich and prosperous, a human being needs to consume more and more energy. (Parul Bisht and Rajni Rawat, 2013), were given some advantages which are: economical and easy to install, nonpolluting, Maintenance cost is low, Installation cost is low and also solve some of the electricity problems of the world. The electricity produced by this system can be used to drive an electric motor or for any other purpose. Their work can be implemented on road and can be used to lighten the street lamps. In future it can be used to charge car batteries also. (N. N. Ghuge et.al, 2014) explains vehicular traffic in big cities is more, causing a problem to human being. It has advantage that it does not utilize any external source. Now the time has come to put forte these types of innovative ideas, and researches should be done to upgrade their implication. It can be implemented at metropolitan cities. So that more electric power is produced. Arrangement of whole setup is easier. The stored electricity could satisfy the daily requirement of electric power. Since the arrangement is easier but power transmission is not as costly as its setup. Hence power can easily be transmitted. (Alok Kumar Singh et al, 2013) This methods have many advantages such as Power generation does not require any fuel input, Running cost is very less, This is a non-conventional form of energy and therefore very useful in the present scenario of energy crisis. As coin has two faces in the same way there are also some disadvantages such as Mechanical moving parts is high and therefore there are very large frictional losses and therefore require more maintenance, Initial cost of this arrangement is very high. The overall efficiency is quite low as compared to other techniques.

## 2. Fabrication

### 2.1 Block Diagram of the design

Figure 2.0 describes a basic outline of the fabrication.

#### 2.2.1 Wooden Table

A *wooden table* is prepared to give support the whole system and also to the speed breaker. Firstly, the frame of the table is prepared by using angular cross sectioned

channels. It is prepared by using simple techniques of cutting, grinding and welding. Wooden planks are then mounted on the table. A large hole, whose dimensions are equal to those of the breaker, is made in the wooden plank in order to house the speed breaker.

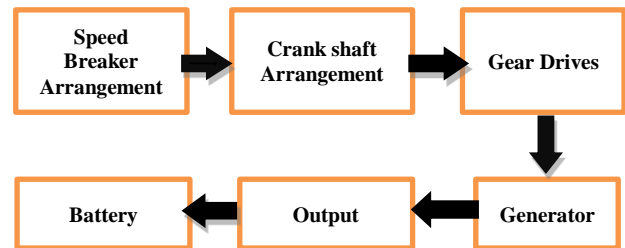


Figure 2.0 Block Diagram



Figure 2.1: Frame of the table (Dimensions of the table: 3×3×4 feet)

### 2.2 Components used in the system

The following components are designed separately and are then assembled to get the power generation system. Wooden Table, Speed Breaker, Connecting Rod, Springs, Crank Shaft, A set of gears, Bearings and AC Generator.

#### 2.2.2 Speed Breaker

*Speed Breaker* is used to transmit the pressure exerted by the vehicle on the connecting linkages, thereby producing mechanical movement in the connecting rod.



Figure 2.2: Speed Breaker (Dimensions of Speed Breaker Cross Section: 1.2 × 3 feet, Length: 3 feet)

The speed breaker is designed to resist the load of the vehicles passing over it. The speed breaker is made up of a single piece of wood. The curvature of the speed breaker

is designed in such a way that the vehicle passes away smoothly over it. The dimensions and cross section of the speed breaker is given above.

### 2.2.3 Connecting Rod

A long strip of width 1 inch is used as a *connecting rod* in this set up. The main function of connecting rod is to transmit the reciprocating motion of the breaker to the crank shaft. One end of the connecting rod is fixed to the speed breaker whereas the other end is mounted on the crank shaft with the help of a bearing.

A connecting rod is an engine component that transfers motion from the piston to the crankshaft and functions as a lever arm. The connecting rod in this system also serves the same purpose. Together with the crankshaft, it forms a simple mechanism that converts reciprocating motion into rotating motion.



**Figure 2.3:** Connecting Rod

### 2.2.4 Springs

*Springs* are used in this system for the following reasons

- To apply force
- To control vibrations
- To control motion
- To reduce impact i.e. as Shock absorbers.



**Figure 2.4:** Helical Springs

Helical Springs used in this system are directly welded to a steel strip which is bolted or fastened tightly to the speed breaker.

### Specifications of the springs used

Type: Helical Springs  
 Material of the spring = ASTM A228 Steel (G = 80 Gpa)  
 Wire diameter of the spring,  $d = 6\text{mm}$

Outer diameter of the spring,  $D = 60\text{m}$   
 Length of the spring,  $l = 240\text{mm}$   
 Number of coils,  $n = 12$   
 Mean coil diameter =  $D - d$   
 $= 60 - 6 = 54\text{mm}$

### 2.2.5 Crank Shaft

The *crankshaft*, sometimes abbreviated to crank, is responsible for conversion between reciprocating motion and rotational motion. In a reciprocating engine, it translates reciprocating linear piston motion into rotational motion, whereas in a reciprocating compressor, it converts the rotational motion into reciprocating motion. The crank shaft used here is connected to the connecting rod by means of ball bearings.

### Specifications of the Crankshaft

Diameter of the cross section of crankshaft = 20 mm.  
 Length of the crankshaft = 2100 mm.  
 Length of the bend = 50 mm.  
 Height of the bend = 30 m



**Figure 2.5** Crank Shaft

### 2.2.6 Gears

Gears are used here for amplifying the speed. The type of gears used in this model is Spur Gears. Two gears out of which one is a pinion and other is a larger gear are used here. These two gears mesh with one another in order to transmit torque.

Two gears working in tandem are called a transmission and can produce a mechanical advantage through a gear ratio. Spur gears or straight cut gears are the simplest type of gear. They consist of a cylinder or disk with the teeth projecting radially, and although they are not straight-

sided in form, the edge of each tooth is straight and aligned parallel to the axis of rotation. These gears can be meshed together correctly only if they are fitted to parallel shafts.

Specifications of Larger Gear

- Material – Stainless Steel (303S31)
- Radial diameter ‘D<sub>1</sub>’ – 190mm
- Number of teeth ‘T<sub>1</sub>’ – 120
- Module = D<sub>1</sub>/T<sub>1</sub> = 1.58
- Pressure Angle = 20°
- Circular Pitch – 4.172mm

Specifications of Pinion

- Material – Stainless Steel (303S31)
- Radial Diameter ‘D<sub>2</sub>’ – 58mm
- Number of teeth ‘T<sub>2</sub>’ – 35
- Module = D<sub>2</sub>/T<sub>2</sub> = 1.65
- Pressure Angle = 20°
- Circular Pitch – 4.172mm



Figure 2.6: Pinion

Figure 2.7: Gear

2.2.7 Bearings

A bearing is a machine element that constrains relative motion and reduces friction between moving parts to only the desired motion. The design of the bearing may, for example, provide for free linear movement of the moving part or for free rotation around a fixed axis; or, it may *prevent* a motion by controlling the vectors of normal forces that bear on the moving parts. Many bearings also *facilitate* the desired motion as much as possible, such as by minimizing friction. Bearings used here are Ball Bearings and are mounted on the crank shaft for connecting the connecting rod.



Figure 2.8: Ball Bearings

2.2.8. AC Generator

An electric generator is a device that converts mechanical energy to electrical energy. A generator forces electric current to flow through an external circuit. The source of mechanical energy may be a reciprocating or turbine steam engine, water falling through a turbine or waterwheel, an internal combustion engine, a wind turbine, a hand crank, compressed air, or any other source of mechanical energy. Generators provide nearly all of the power for electric power grids. An AC generator is coupled with the shaft on which the pinion is mounted.

Specifications of the Generator

- Current Capacity – 1Amp
- Voltage – 12V
- 1Kg Torque



Figure 2.9: Generator

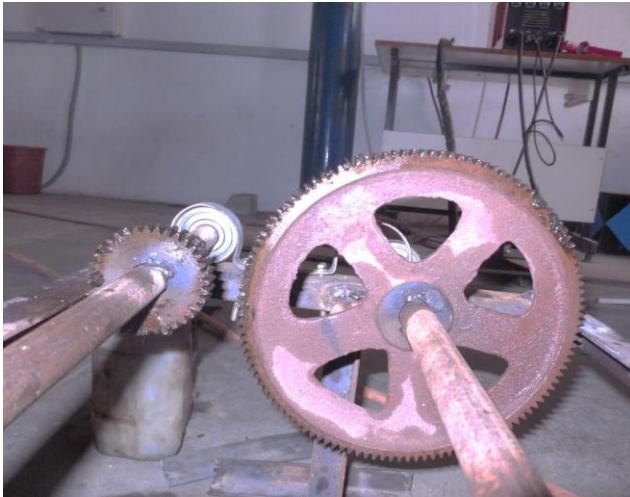
2.3 Processes employed in Fabrication of Power Generation Setup

This chapter at present is about the literature review of various processes involved in the fabrication such as welding, cutting, and drilling and others. Before fabrication process, material selection is crucial. The sequence of assembling of all the fabricated components is also very important to get a product that can withstand any magnitude of pressure from the vehicle.

3. Working Principle

The work is concerned with generation of electricity from speed breakers-like set up. The load acted upon the speed breaker - setup is there by transmitted to gear and pinion arrangements.

Here the reciprocating motion of the speed-breaker is converted into rotary motion using the connecting rod and crank shaft arrangement. The axis of the crankshaft is coupled with the larger gear. The gear arrangement is made up of two gears. One of larger size and the other of smaller size. Both the gears are connected are meshed directly which serves in transmitting power from the larger gear to the smaller pinion. As the power is transmitted from the larger gear to the smaller pinion, the speed that is available at the larger gear is relatively multiplied at the rotation of the smaller pinion.



**Figure 3.1:** Transmission of power through Gear

The axis of the smaller gear is coupled to a gear arrangement. Here we have two gears with different diameters. The gear wheel with the larger dimension is meshed to the axis of the smaller pinion. The smaller gear is coupled to the larger gear. So as the larger gear rotates at the multiplied speed of the smaller sprocket, the smaller gear following the larger gear still multiplies the speed to more intensity.

Hence, although the speed due to the rotary motion achieved at the larger gear wheel is less, as the power is transmitted to gears, finally the speed is multiplied to a higher speed. This speed which is sufficient to rotate the rotor of a generator is fed into the rotor of a generator. The rotor which rotates within a static magnetic stator cuts the magnetic flux surrounding it, thus producing the electric motive force (emf). This generated emf is then sent to an inverter, where the generated emf is regulated. This regulated emf is now sent to the storage battery where it is stored during the day time. This current is then utilized in the night time for lighting purposes on the either sides of the road to a considerable distance.

### 3.1 Photograph of the assembled model

The figure below shows the photograph of the assembled



**Figure 3.2:** Assembled Model of Speed Breaker Power Generation System

## 4. Design Calculations

### 4.1 Design of springs

Material of the spring = ASTM A228 Steel (G=80 Gpa)

Wire diameter of the spring,  $d = 6\text{mm}$

Outer diameter of the spring,  $D = 60\text{mm}$

Length of the spring,  $l = 240\text{mm}$

Number of coils,  $n = 12$

Mean coil diameter =  $D-d$

=  $60 - 6 = 54\text{mm}$

Stiffness of the spring,  $k = \frac{G \times d^4}{8 \times D^3 \times n}$

$$= \frac{80 \times 10^4 \times (6)^4}{8 \times (54)^3 \times 12}$$

$$= 6.9 \text{ N/mm}$$

### 4.2 Calculation of Load

Stiffness of springs  $k = \text{load/deflection}$

Therefore, load,  $w = k \times \text{deflection}$

=  $6.9 \times 60 = 414 \text{ N}$  (We assume maximum deflection =

$60\text{mm}$ ) as we are using two springs of same specification

total load  $W = 2 \times w$

=  $2 \times 414 = 828 \text{ N} = 84.4 \text{ kg}$ .

### 4.3 Calculation of Speed Multiplication

Speed ratio =  $T_2/T_1 = 35/120$

=  $N_1/N_2 = 0.29$

Where,  $N_1 = \text{speed of the gear}$

$N_2 = \text{speed of the pinion}$

$T_1 = \text{number of teeth in gear}$

$T_2 = \text{number of teeth in pinion}$

$N_2 = N_1/0.29$

if the speed of the gear  $N_1$  is 20 RPM then, the speed of the

pinion  $N_2 = 20 / 0.29$

=  $68.57\text{RPM}$

### 4.4 Calculation of torque

Torque,  $T = \text{force} \times \text{perpendicular distance}$

=  $828 \times 30 \times 10^{-3}$  (perpendicular distance =  $30\text{mm}$ )

=  $24.840 \text{ N-m}$

Torque obtained at the pinion =  $24.84 / 3.42$

=  $7.26 \text{ N-m}$

### 4.5 Design of Crankshaft

From Torque Equation,

$T/J = \tau/R = G\theta/l$

Where,  $T = \text{maximum twisting moment (N-mm)}$

$\tau = \text{maximum shear stress (50MPa)}$

$R = \text{radius of shaft (mm)}$

$J = \pi D^4 / 32$  ( $D=2R$ )

$D = \text{shaft outside diameter (mm)}$

$l = \text{length of the shaft (2.1 m)}$

$\theta = \text{angle of rotation}$

=  $2.5^\circ = 0.0436 \text{ radians}$

**On the basis of strength,**

$$T/J = \tau/R$$

$$R^3 = \frac{32 T}{16 \pi (\tau)} \quad (\text{Substituting the value of } J)$$

$$= \frac{32 \times 24.84 \times 10^3}{16 \times \pi \times 50}$$

$$= 316.272$$

$$R = 6.813 \text{ mm}$$

Therefore, we get the diameter of crank shaft as 13.62 mm.

**On the basis of Rigidity,**

$$T/J = G\theta/l$$

$$R^4 = \frac{32 \times T \times l}{16 \times \pi \times G \times \theta}$$

$$= \frac{32 \times (24.84 \times 10^3) \times (2.1 \times 10^3)}{16 \times \pi \times (80 \times 10^3) \times 0.0436}$$

$$= 9513.5728$$

$$R = 9.876 \text{ mm}$$

Therefore, we get diameter of crank shaft as 19.75 i.e. 20 mm approx. So we proceed with the highest value of the both diameter.

**5. Results**

*5.1 Estimated power output*

$$\text{Power} = \frac{2 \pi N T}{6} \quad \text{watts}$$

$$= \frac{2 \times \pi \times 68.57 \times 7.26}{60} = 52.13 \text{ watts}$$

Power obtained in 24 hours = 3.4 MW (approx.)

*5.2 Experimental Results*

The voltage generated at different load Conditions are observed and readings are tabulated as shown below.

**Table 5.1:** Output at different Loads

Load(kgs)	Voltage Generated(V)
40	6.58
60(man load)	8.33
130	9.45
170	10.22
200	11.23

*5.3 Advantages of Power Generation System using Speed Breaker*

- Pollution free power generation
- Simple construction, mature technology, and easy maintenance.
- No manual work necessary during generatio
- Energy available all year ro
- No fuel transportation pro
- No consumption of any fossil fuel which is non-renewable source of energy.

**Conclusion**

The utilization of energy is an indication of the growth of a nation. One might conclude that to be materially rich

and prosperous, a human being needs to consume more and more energy. And this project utilizes the best source of energy that we get in day to day life. It is a non-conventional type of producing the energy. The existing source of energy such as coal, oil etc may not be adequate to meet the ever increasing energy demands. These conventional sources of energy are also depleting and may be exhausted at the end of the century or beginning of the next century. Consequently sincere and untiring efforts shall have to be made by engineers in exploring the possibilities of harnessing energy from several non-conventional energy sources. This project is a one step to path of that way.

The overall goal was to design the speed breaker System while keeping the engineering, producer and customer models in check. The reason why this feature was used more than all of the other features are because the other features would not have as much effect on the complete system. By changing the size and desirable price, weight and capacity can be realized. Future work would consist of a redesign of this model to see exactly how much data we may be missing with the assumption that we made with low price, weight and capacity.

**Scope for Future Work**

- The gear transmission can be replaced by a series of chain drives for more power production
- A provision can be made for storing the generated power in a battery and utilizing in future.
- Stress analysis can be carried out on the speed breaker. Speed breaker can be designed in a more compact manner in order to resist the heavy load.

**References**

Selvaraj, R.S., Sivamadhavi, V. (2010), Magnitude of Green House Effect and the contribution of Carbon di oxide, *Recent Advances in Space Technology Services and Climate Change (RSTSCC)*, 13-15 , no. 41 – 44, Chennai.

Shakun Srivastava, Ankit asthana, (2011), produce electricity by the use of speed breakers, *Journal of Engineerin g Research and Studies*, Vol.2, No.1.

Mukherje, D., Chakrabarti, S, (2005), Non-conventional power plants, New Delhi

Sharma.P.C, (2003), Principles of renewable energy systems, *Public printing service*, New Delhi.

Watts. (2004), Effects of speed distribution on the Harmonies model predictions, *Inter-noise Conference*, Prague.

Aswathaman.V and Priyadharshini.M, (2011), Every Speed Breaker Is Now A Source Of Power, *International Conference on Biology, Environment and Chemistry*, IPCBEE vol.1 IACSIT Press, Singapore.

Parul Bisht and Rajni Rawat, (2013), Electricity Generation through Road Ribs using law of Electromagnetic Induction, *Conference on Advances in Communication and Control Systems*, (CAC2S 2013).

N. N. Ghuge, Arati Sathe, Varsha Patil, Anagha Warankar, (2014), Every Speed Breaker Is A Source of Power, *International Journal of Engineering Research and Applications*, ISSN: 2248-9622, Vol. 4, Issue 3(Version 6), pp.01-05

Alok Kumar Singh , Deepak Singh, Madhawendra Kumar,Vijay Pandit and Prof.SurendraAgrawal, (2013), Generation of Electricity through Speed Breaker Mechanism, *International Journal of Innovations in Engineering and Technology (IJIET)*, Volume-2, Issue-2, ISSN:2319-1058.