INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact factor: 4.295
*(Volume 4, Issue 4)*
Available online at: www.ijariit.com

# Design and fabrication of reciprocating ramp for power generation

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## ABSTRACT

***In the present position, energies are the basic need for human life and a must needed factor for the country's economic development. Currently, for today's world, we bank on conventional sources for the maximum energy required. But the population is increasing day by day and also the requirement for energy is also growing exponentially, so there is a need for alternate sources from which energy can be tapped economically and eco-friendly. The new source of energy is created by the conversion of one form of energy into other. Number of vehicles is increasing day by day and a large amount of energy is being wasted at the speed breakers in the form of kinetic energy, in the present work we are making an attempt to fabricate a ramp, which can utilise the kinetic energy of the vehicle in power generation This paper prominence the idea to use kinetic energy of vehicle when it is moving over the speed breaker. This kinetic energy can be converted into mechanical energy which is utilized to produce power by using specially designed mechanical structure naming "RECIPROCATING RAMP". In this paper, it is clearly explained the working principle of the "RECIPROCATING RAMP", its practical implementation, testing of the structure, and results obtained for different vehicle loads. A geometrical model of the system has been modeled using Creo Parametric. Determining the different factors that determine the power generation, graphs have been plotted for various inputs. Electricity generated is stored in the battery. Electricity stored in the battery is used to run various electrical appliances.***

***Keywords:*** *Reciprocating ramp, Speed breaker, Flywheel, Generator*

## 1. INTRODUCTION

Today our entire daily life is dependent on electricity. With the increasing population, the demand for electric power is also increasing. But we are left with limited resources to generate electricity, and this has created a need for innovation in this field. Power generation from a speed breaker is a new concept that is under research.

The number of vehicles on road is increasing rapidly and if we convert some of the kinetic energy of this vehicle into the rotational motion of generator then we can produce a considerable amount of electricity, this is the main concept of this project. It involves the power generation by speed breakers (speed power generation), which is one of the recent concepts.

This project attempts to show how energy can be tapped by using the reciprocating ramp. This type of ramp is best suited for the places where the speed breaker cannot be replaced, like parking lots, toll gates, flyovers, runways, sewer system across roads which are best for its utilization. It utilizes the kinetic energy of the locomotives and has an advantage over speed breaker system, i.e. the vehicles passing over speed beakers slowdown, which reduces the kinetic energy acting on the system. This is not seen in this system.

This project focuses on the utilization of derived energy from moving vehicles. The aim of this project is to design and implement a reciprocating ramp system that has the ability to operate in both high and low vehicle speed conditions. Our choice for this model is to showcase its efficiency in varying load and speed conditions as compared to the speed breaker energy generation system and contribute to itself for the purpose of a reliable source of power generation.

## 2. WORKING OF RECIPROCATING RAMP

The ramp is placed in the ground level and is inclined at a certain angle, the ramp is connected to the gravity weights which helps in the repositioning of the ramp.

In the first half when a vehicle passes on the ramp it is pushed down, a rack is attached to the ramp which drives a pinion when the pressing happens, the pinion is coupled to the shaft with sprocket mounting on it to transfer the power to another shaft placed parallel to it. The rotation of the shaft causes the sprocket which in turn rotates the smaller sprocket on the parallel shaft so that the net RPM is increased.

Flywheels are mounted on the parallel shaft to store the mechanical energy, also Flywheels are used for providing the freeway mechanism i.e.in the first half when front wheel of vehicle is passed the shaft rotates in anti-clockwise and in the next half when the gravity weights (dead weights) pulls back the ramp to its original position shaft rotates in clock-wise direction. Flywheels are coupled to generators through belt drives.

So during the first half of the working cycle first flywheel is in action and drives the one generator and during the second half other flywheel is in action and drives another generator. The power generated from generators are stored in the battery and used for secondary purposes

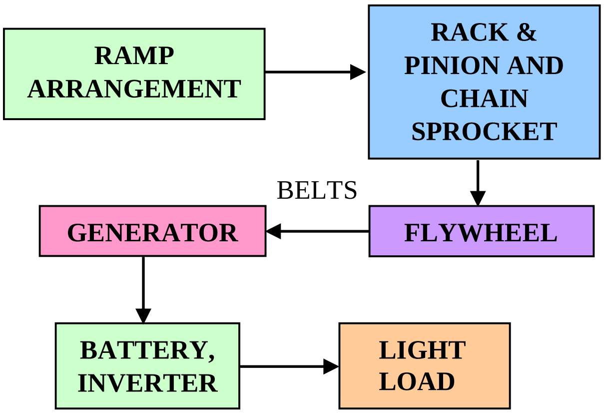



**Fig. 1: Working of the reciprocating ramp**

## 3. ENERGY ESTIMATION

Theoretical power is calculated based on the height of the ramp and assuming ideal conditions.

### 3.1 Forward stroke

The mass of the vehicle including human weight =200Kg (Approximately)

The height of reciprocating ramp from ground =0.14m

∴ Work done = Force X Displacement

Here,

Force = Weight of the Body
= 200 Kg x 9.81
= 1962 N

Distance travelled by the body= Height of the reciprocating ramp
= 0.14 m

∴ Output power= Work done/Sec
= (1962 x 0.14)/60
= 4.57W
(For one push of the ramp)

### 3.2 Return stroke

The mass of dead weight = 16Kg (Approximately)
Height of ramp = 0.14m

∴ Work done= Force X Displacement

Here,

Force = Weight of the dead weights
=16 Kg x 9.81
=156.96 N

Distance travelled by the body= Height of the ramp
= 0.14 m

∴ Output power = Work done/Sec
= (156.96 x 0.14)/60
= 0.36 W

## 4. DESIGN AND DRAWINGS

### 4.1 Pinion design

From **K Mahadevan** design data book (page no.205 eq-12.7)

$$F_t = \frac{1000PC_s}{v}$$

We get,

Where $F_t$ is tangential tooth load in N

$C_s$ is service factor form table 12.8

P is power in $K_w$

Power transmitted =4.57 W

Assumed Z=20

$$F_t = \frac{409.5}{m} \qquad (1)$$

**Lewis equation eq 12.5(a)**

$F_t = \sigma_d C_v byp$

$\sigma_d$ = 78.5 MN allowable static stress table 12.7

$C_v$ = Velocity factor

$$C_v = \frac{3}{3+v} = 0.99 \qquad \text{eq 12.6(a)}$$

$$F_t = 302.103\, m^2 C_v \qquad (2)$$

Equating equation 1 & 2 we get, $m^3 C_v = 1.355$

By trial and error method we get, m=1.15

Taking std. m=1.5

We have,

D = m*Z eq 12.1(e)
D = 1.5x20
D = 30 mm

### 4.2 Rack design

Module = 1.5
Pinion diameter =30mm
Circumference =94.2mm
For one and half revolutions =141mm
No. of teeth on rack = 30
Length of rack > 141 =145mm

## 5. MATERIALS USED

### 5.1 Rack

**Fig. 2: Rack used to drive pinion**

Specifications:

- Material: cast iron
- Length: 300 mm
- No of teeth: 32
- Module: 1.5

### 5.2 Pinion gear

**Fig. 3: Pinion used for transmission**

Specifications:
- Material: cast iron
- Max allowable stress: 78.5 Mpa (DDHB table 12.7)
- Pitch circle diameter: 30mm
- No. of teeth: 20
- Module: 1.5

### 5.3 Stepper motor

**Fig. 4: Stepper motor**

Specifications:
- Weight : 250 gms
- Voltage : 12v ac
- Step angle :1.8 deg

### 5.4 Flywheel

**Fig. 5: Flywheel**

Specifications:
- Density: $7850 kg/m^3$
- Tensile strength: 370 MPa
- Modulus of Elasticity:205GPa

### 5.5 Shaft

**Fig. 6: Cast iron shaft**

Specifications:
- Material: cast iron
- Max allowable stress: 78.5 Mpa
- diameter: 12mm
- length: 340, 410 mm

### 5.6 MS hollow bars

**Fig. 7: MS Hollow bars**

Specifications:
- Dimension: 40x40x2
- Density: $7850 kg/m^3$
- Tensile strength: 370 MPa
- Modulus of Elasticity: 205GPa

## 6. FABRICATION AND ASSEMBLY DRAWINGS OF MODEL

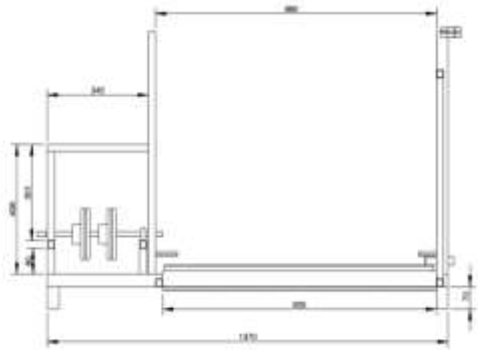


**Fig. 8: Front view**

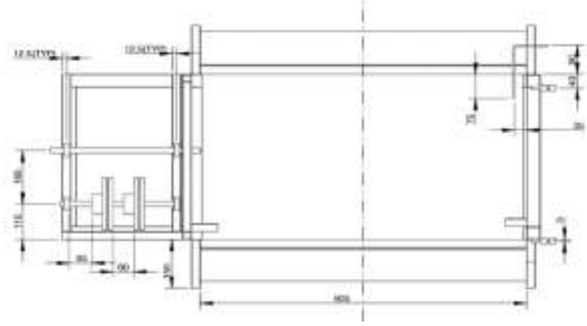


**Fig. 9: Top view**

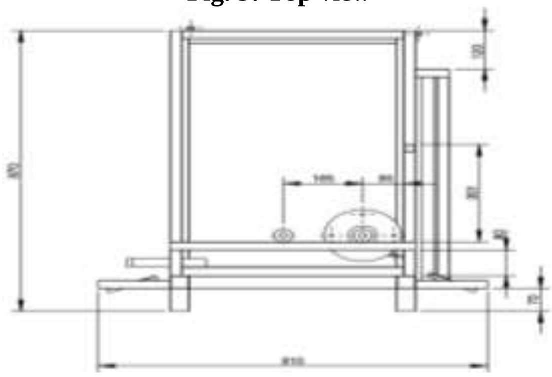


**Fig. 10: Left view**

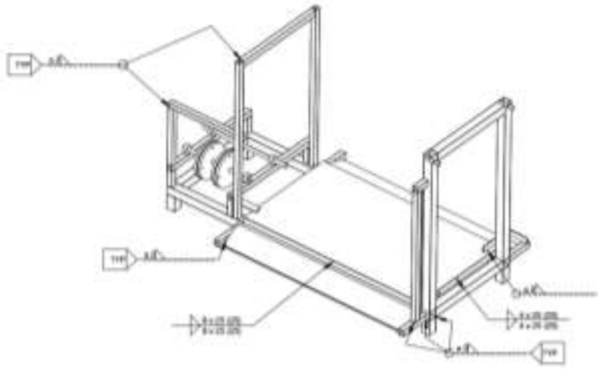


**Fig. 11: Welding detail**

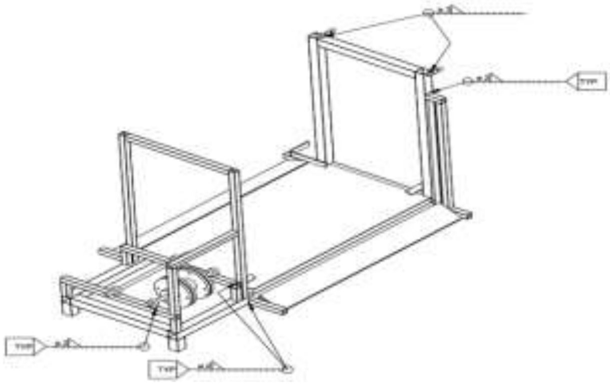


**Fig. 12: Fabricated model**

**Fig. 13: Fabricated model design**

## 7. EXPERIMENTING AND TESTING

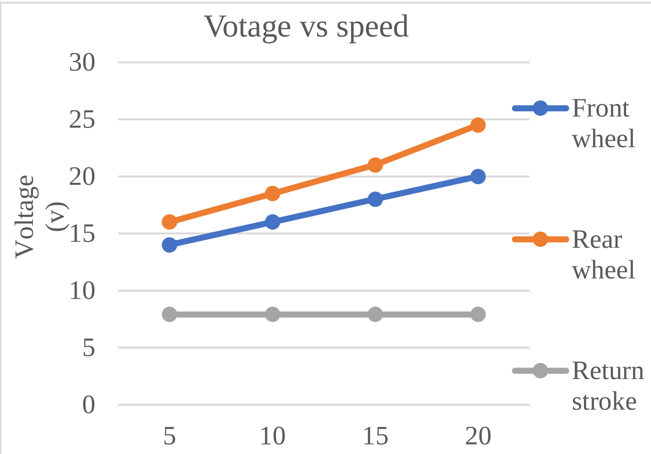
### 7.1. Voltage with constant weight

### 7.1.1 Forward movements of the ramp

Vehicle: Honda active

**Table 7.1: Honda Activa voltage readings**

| S. No | Vehicle speed (in Km/h) | Front wheel voltage in volts | Rear-wheel voltage in volts |
|---|---|---|---|
| 1 | 5 | 14 | 16 |
| 2 | 10 | 16 | 18.5 |
| 3 | 15 | 18 | 21 |
| 4 | 20 | 20 | 24.5 |



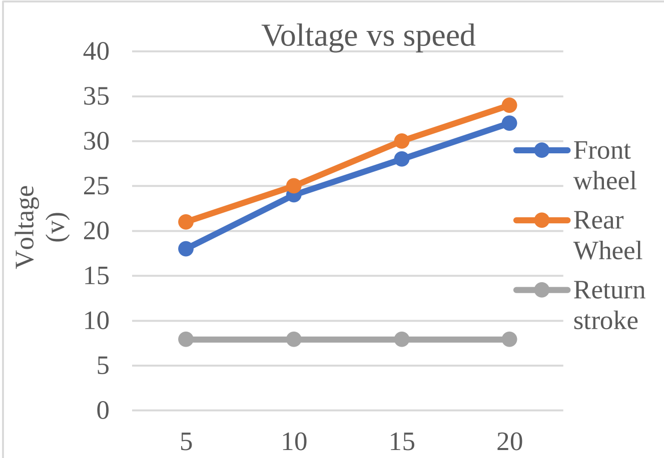

**Graph 7.1: Voltage vs. speed of Honda Activa**

### 7.1.2 Forward movement of the ramp

Vehicle: Yamaha Fz

**Table 7.2: Fz voltage readings**

| S. No | Vehicle speed (in Km/h) | Front wheel voltage in volts | Rear wheel voltage in volts |
|---|---|---|---|
| 1 | 5 | 18 | 21 |
| 2 | 10 | 24 | 25 |
| 3 | 15 | 28 | 30 |
| 4 | 20 | 32 | 34 |




**Graph 7.2: Voltage vs. speed of Fz**

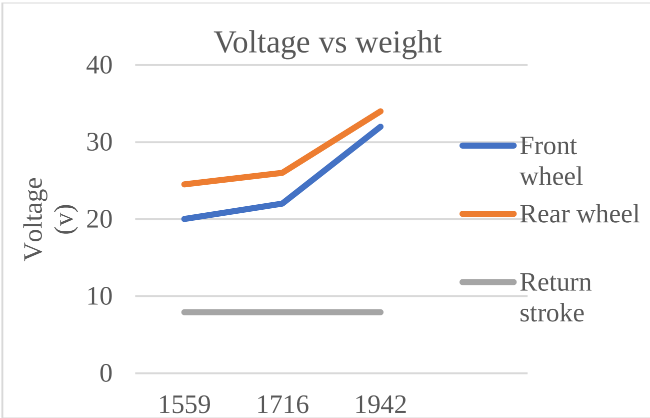
### 7.2 Voltage with constant speed

### 7.2.1 Forward movement

Speed: 20kmph

**Table 7.3: Combined voltage readings for constant speed**

| S. No | Vehicle weight (in N) | Front wheel voltage in volts | Rear wheel voltage in volts |
|---|---|---|---|
| 1 | 1559 | 20 | 24.5 |
| 2 | 1716 | 22 | 26 |
| 3 | 1942 | 32 | 34 |




**Graph 7.3: Voltage vs. speed for constant speed**

## 8. CONCLUSION

In concluding our project, since the power generation using reciprocating ramp provides energy requirements from the indirect source of waste energy, there is no need of power from the main conventional sources and also there is less pollution induced in this source of energy. It is very useful when placed on roads replacing the speed breakers. It is able to extend this project by using the same arrangement which replaces the speed breaker energy generation system. This system can also be placed on highways, flyovers, parking lots, tolls etc.

## 9. RESULTS

- The maximum voltage obtained for Honda Activa at 20 kmph weighing 109 kilograms is 24.5 volts.
- The maximum voltage obtained for Hero Honda at 20 kmph weighing 112 kilograms is 26 volts.
- The maximum voltage obtained for Fz at 20 kmph weighing 148 kilograms is 34 volts.

- The maximum voltage obtained was observed to be 7.9 volts for the return stroke due to a constant load of dead weights i.e, 16 kilograms.
- The graphs indicate the readings obtained in the test observation.
- It was observed that the voltage increases with increasing weight and speed.
- The output can be multiplied by providing a number of slots on the flywheel and connecting to multiple generators.

## 10. ACKNOWLEDGMENTS

We would like to thank faculties of **Department of Mechanical Engineering** and our project guide **Mrs. Nithya Poornima** for their support and help in carrying out the project.

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