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SUSTAINABLE MASS TRANSIT SYSTEM EQUIPPED WITH KINETIC RAMP AND FOOTFALL

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Abstract — *The environmental effects of transport itself are enormous as Vehicular Emission causing Air pollution, Noise Pollution, Fatalities etc, that erodes the natural resource base of an economy besides polluting the environment in a big way. This paper proposes advancement in mass transit systems by equipping them with alternative energy generated by mechanical ramps and foot fall that generates electricity by harnessing the kinetic energy generated by automobiles and commuters passing over it. The electricity hence generated would be renewable and sufficient enough to run the nearby street lights, stops or terminals and fare collection stations, making the mode of transit self- sustaining. A brief application has been shown in this paper along with the mechanics upon which this method works and the expected economic outputs are also proposed.*

Keywords- *sustainable, kinetic energy, Alternative energy, ramp model, electricity, footfall, mass transportation*

I. INTRODUCTION

With the electronic devices becoming integral part of day-to-day life, both in personal and industrial environments, the demand for energy is tremendously increasing across the globe. In the effort to find alternative sources to supplement the conventional energy sources, the energy industry has found the feasibility in fossil fuels, nuclear, thermal, hydro, solar etc. This energy ramp is an extensive approach in the field of alternative renewable energy. It is a mechanism to produce electricity by harnessing the kinetic energy of vehicles that drives over the ramp. The objective is to design a system that decreases the energy crisis in world by utilizing the vehicles kinetic energy. The system can be implemented just before or just after the entrance of e.g. Tool Plazas, Hospitals, U-turns, Airports etc.

II. KINETIC ENERGY : GENERATION – HOW DOES IT WORK?

There are multiple ways to harvest kinetic energy:

- Piezoelectric: A piezoelectric element like PZT, PVDF, etc., is used as transducer means to convert the kinetic energy into electrical energy upon stepping on the floor tile. Deformation of the piezoelectric element caused by the load acting the tile induces charges which can be siphoned off.
- Magnetic: Transducer means comprises a magnetic element and a conductive element, wherein one of the elements is movably coupled to the floor surface. When a pressure is applied on the floor surface, the conductive element cuts the magnetic flux and so current is induced in the conductive element.
- Generator: A mechanical arrangement viz. hydraulic, pneumatic and spring is coupled to the floor surface, such that a rotor of a micro-generator arranged in the floor tile is driven by the mechanical arrangement when a force acts on the floor surface
- Static: A capacitor is formed in the floor tile by using two charging layers uniformly separated by a small gap, wherein one layer is coupled to the tile surface through springs. By pressing the tile surface, the gap between the layers is altered and so charges are induced in the layers. These charges can be extracted by suitably connecting the layers to an external circuit.

III. THE TECHNOLOGY BEHIND THE ENERGY RAMPS

- Requirements:
  - Cylinder and piston
  - Control valves
  - Oil tank
  - Generator coupled with turbine

- Block Diagram:

This system is to generate power by converting the energy generated by a vehicle going up on a ramp into electrical energy. This arrangement consists of ramp assembly, cylinder and piston arrangement, water turbine, Generator and Stabilizing Unit with battery for storing the generated output.

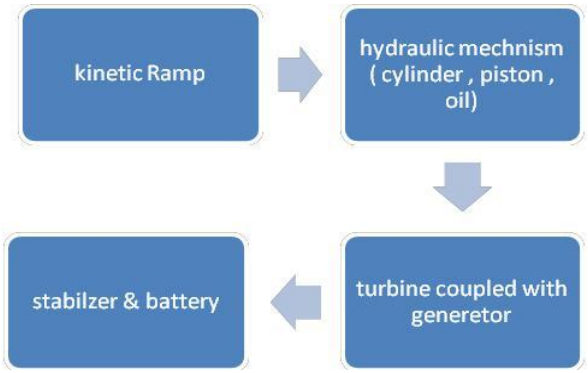

Figure 1 Block Diagram

A. Working Principle

When the vehicle (load) passes over the speed bumper which is made of cylinder and piston arrangement, then the piston rod is subjected on a compressive force which in turn the oil gets pressurized and comes out through the outlet nozzle which strikes the turbine blades then the potential energy of oil is used to run the turbines to which the electric generator is coupled. Here the mechanical energy available at the speed bumper is converted in to electrical energy through a generator.

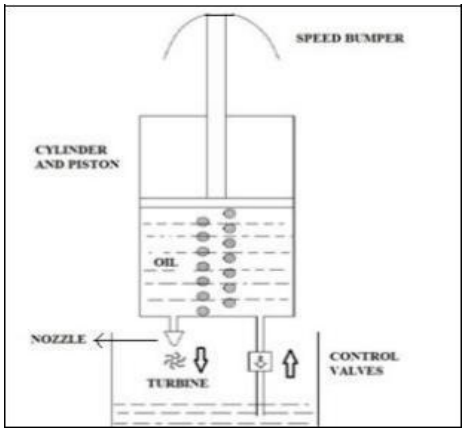

Figure 2 working of Ramp

Due to spring tension, the exhausted oil is recycled back to the cylinder with the help of inlet control valve. Hence, the speed breaker gets back to its original position. So, if we implement one such speed breaker on a busy highway, we can able to tap maximum amount of electricity from the waste kinetic energy of a vehicle.

Figure 3 Kinetic Ramp

Figure 4 Ramp

B. Power output calculations

Power developed is given by P = (2πNT)/60
Where,
N = speed in revolution per minute
T = output torque Analyzed speed
N = 500rpm,

By substituting the values of N and T we get
P = (2*3.14*500*5.062) / 60
Output power P = 4.5 watts
In this mechanism, generated power is directly proportional to the area of cylinder.

Table 1: Output power relation

Sr no.	Radius of cylinder (cm)	Area of cylinder (m2)	Output power (watts)
1	5	0.00785	4.5
2	10	0.03	70.5

IV. KINETIC FOOTFALL

The working mainly depends on piezo plates .The energy harvesting aspect of these piezoelectric floor tiles lies in the unique properties of the crystal structure. Certain ceramics, such as lead zirconate titanate form a tetragonal structure with a small atom in the center. When the crystal is strained, the center atom displaces from its lattice site and creates a potential. In our case, this displacement allows for energy harvesting of the depression caused during foot strike. The energy output of these types of energy harvesting tiles depends upon the applied force; a larger stress corresponds to a larger potential difference and thus more energy. In order to estimate the power output of a single person walking through the campus center, it is important to determine the magnitude of forces experienced.

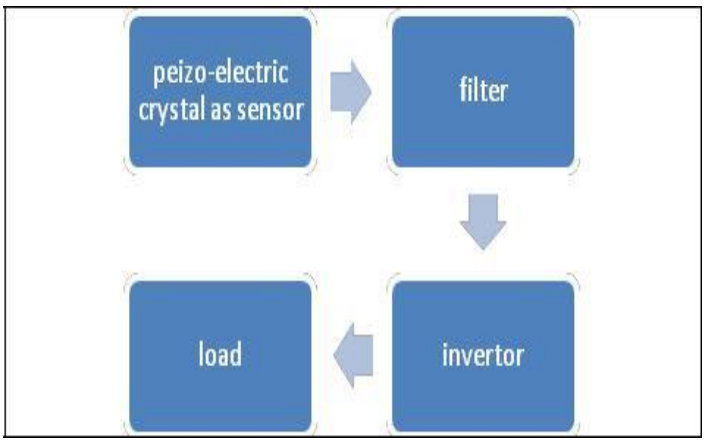

Figure 5 Footfall

A. Working Principle

The Energy Floor module flex slightly when stepped on which creates a movement that can be transformed by a small internal generator each module by the size of 75 X 75 X 20 cm can produce up to 35 watts of sustained output between 5 to 20 Watt per person.

V. APPLICATION IN MASS TRANSIT

- **Bus Stops**: On various platforms and terminals from where the buses enter and exit the bus station; kinetic Ramps could be constructed and energy could also be harvested by placing footfall tiles all over the bus station.

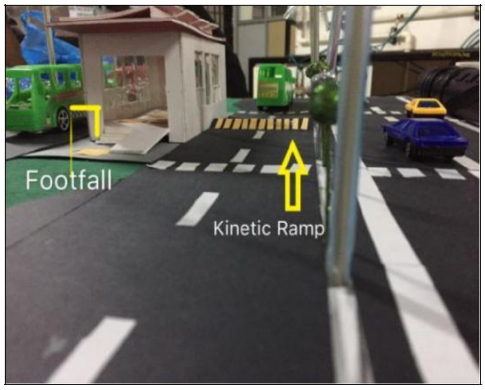

Figure 6 position of ramp on bus terminals

Figure 7 proposed model

For example: BRTs lanes; in Bus Rapid transit, dedicated lanes are provided to buses amidst the arterial roads.

Figure 8 Footfall on subway

- **Railways, Metro or Subways**: Kinetic footfalls could be placed all over the area and also at car parkings kinetic ramps could be placed.

- **Toll plazas**: Kinetic ramps have the most efficient application on Toll plazas.

Recreational places and Dance floors: The Sustainable Energy Floor is a fully recyclable pedestrian floor which can be used in pavements and high footfall areas, such as sport arenas, airports, railway stations, shopping malls, office and apartment blocks. This dance floor can use human movement as source of energy. This kinetic energy is converted to electricity which powers the floor's LED lights. The floor interacts with the public and involves them in an interactive energy experience. The generated electricity can be used to power one of our Energy Plugins, like digital energy meter, photo appplication or LED battery.

VI. CONCLUSION

This process can actually be concluded as an evolution in transport-infrastructure and energy harvesting. While considering a toll plaza, nearly 15 vehicles passing per minute; the average kinetic force obtained from the vehicles is around 1000 N at speed bumper. Hence, the power produced from this mechanism is estimated around 500 Watts. While a typical fan consumes 75Watts and a tubelight consumes 50watts ; an output of 500 watts is more tham sufficient to make the system self sustaining.

VII. ACKNOWLEDGEMENT

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