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SELF ILLUMINATING BRTS STOP (SIBS) USING PIEZO-TRANSDUCER

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ABSTRACT

This project involves discovering new techniques for sustainable development and making the bus rapid transit system (BRTS) corridors more energy efficient and cost efficient from development point of view. It is more energy efficient than conventional bus systems. The aim of this paper is to develop the piezoelectric material as a power generator for these applications. This project supports the utilization of this force per area power by converting it into electrical energy through the means of piezoelectric effect which is the ability of certain materials to generate an electric charge in response to applied mechanical stress. This energy could be stored and used as per the requirement of the BRTS corridors making it more cost efficient by reducing the costing of lightening the corridors.

KEYWORDS*:* Introduction, Background, Present Energy Scenario, Cost Consumption in BRTS, Loss of Energy, Alternative Source, Where & How to Implement, Implementation Analysis, Advantages, Applications, Future Vision, Conclusion

INTRODUCTION

Each day approx 1.5 lakh passengers use the transportation through buses, making bus transportation their keen priority. As being witnessed in many cities, BRTS can make an important contribution towards promoting sustainability of urban transport systems. It is more energy efficient than conventional bus systems. This project involves discovering new techniques for sustainable development and making the bus rapid transit system (BRTS) corridors more energy efficient and cost efficient from development point of view. In this era of increasing energy costs and decreasing supplies of fossil fuels, emphasis on protecting the environment and creating sustainable forms of power have become vital, high priority projects for modern society. One such idea that will fit well in BRTS setting is the capturing of kinetic energy from passenger foot traffic. This novel idea termed as piezoelectricity is not only clean but it is also renewable A lot of waste energy of heat, vibration, wind energy and natural wind energy can be harvested into useful energy by using technology of piezoelectric devices. The application of piezoelectric as a power generator can be extended to operate daily low power electrical appliances such as tuner, light bulb, mobile phone and so on.

BACKGROUND

India is witnessing massive construction activities in infrastructure sectors. Talking about our city of survey, during early stages of urbanization Bhopal used to have only non-mechanized mode of transportation in the form of tangas. The growth has called for an urgent need in stepping up public transportation requirements.

Thus, as per our survey city Bhopal, BRTS (Bus Rapid Transit System) was best suited in mid-size cities like Bhopal with lack or deficient bus services, where the social structure is basically middle class, where there is high demand of transportation with security. Hence there was a need to wean people away from private vehicles and persuade them to use public transport. The only way this could be done is by introducing a good Public Transport System and BRTS was the

best option for Bhopal city.

PRESENT ENERGY SCENARIO

Present energy production and the fulfilment of the vital energy requirement by the citizens, if the government could establish, then only the government is called successful. If this energy is lost in such areas where it could be saved, then such modes of power saving should be thought off.

In our survey city Bhopal, Construction and maintenance stages of transport projects are usually ignored while understanding the energy impacts. as we know that main need of energy is in the form of electricity today. But, according to continuous increase in Power Generating and Transmission capacity in Bhopal – Electricity sales increased by 2.10% in 2008-09 – 64% rural electrification; electrification of 228 villages during 2009-10 (till Dec 09) – 24 hrs electricity supply to industries since 2005-06 – Plant Load Factor improved from 60% to 69% – 1000 MW power available from Electricity Banking.

This energy is produced from diverse forms of renewable energy sources (wind, biomass, small hydro, solar). The gross electricity production of Madhya Pradesh has:

Table 1: Energy Production Scenario in Madhya Pradesh

S.No.	Renewable Source	Power Obtained (watt)
1.	Wind energy	1200 MW
2.	Biomass	1040 MW
3.	Hydro energy	410 MW
4.	Solar energy	20 MW/sq. Km

Some possible areas where energy reduction can be achieved during the life of a transportation system are:

- Reducing energy consumption and using alternative materials that use comparatively less energy
- Using locally available materials,
- Promoting inter-modal shift (towards more energy efficient modes),
- Reducing energy and material intensity during manufacturing

Maintenance of constructed assets in less energy consumption should hence be given due importance; it will help reduce both monetary and environmental costs on a life cycle basis.

Given the far-reaching effects that transportation has on energy consumption sustainable transport systems will be a key building block for future thriving cities. A sustainable approach therefore includes social benefits, such as reducing fatalities related to traffic, energy production if possible, as well as long-term economic development goals.

COST CONSUMPTION IN BRTS

Apart from the construction and material cost of the BRTS lanes and buses, there are several other costing parameters which include lightening, fuelling, etc for the BRTs.

According to the theme of our paper, the cost parameters for BRTS lightening includes the material used and the effective amount of power consumed by that material for lightening the lanes, the cost obtained in the electricity bill by

that material for each month according to the norms of MPEB.

As per our survey, there are total 82 BRTS stop routes in the city.

- Then total number of BRTS stops that could be used in our project =82

Figure 1: The 40 Watt T-12 Tube Lights on BRTS Stop, Indicated by Arrows

- Each of the stop has 18 tube lights for lighting purpose
- Each tube light consumes about 40watt of power in one hour
- The tube lights glow form 6pm in evening to 6 am in morning i.e. 12 hours
- The total power consumption in one day for one stop would be then = 40*12*18 = 8.640 Kilowatt.
- According to the norms of MPEB, the costing as per power used is stated below:

Table 2: The Cost of Electricity in Madhya Pradesh

Unit	Initial	New Cost
Upto 50 units	3.30 per unit	3.40 per unit
51-100	3.75	3.85
101-300	4.60	4.80

- Per unit cost = 3.40. Thus for 8.64 units = 29.376rs per day
- Total monthly power consumption per stop = 259.2 kW
- Total monthly cost consumption on electricity per stop = 881.28rs
- Total monthly power consumption for 82 stops = 21254 kW
- Total monthly cost consumption on electricity for 82 stops = 72,264.96 rs.

LOSS OF ENERGY

Electrical energy is one of the most vital forms of energy needed for various operations in day to day life. Majority of the subsystems runs on electrical energy. Presently, electrical energy is the mostly needed form of energy

which is being lost in the lightening of BRTS stops as proven in the above calculations. This energy, if could be saved, then it can be utilized in many other forms as a feed. Also, the need of electricity in the village area and the farming field can be fulfilled by this power saved from the stops.

Such problems can be alleviated through the use of power harvesting devices. Thus, we require methods to utilize the energy of a system, which is lost to the surroundings and convert it into feasible energy for the electrical device consumption.

ALTERNATIVE SOURCE

As we know that number of people on daily basis, make use of BRTS stops for taking the buses for different routes. If we are able to transform this mechanical energy by them in some useful form, our work will be done. One of the promising options is by using piezoelectric material or PZT. PZT can be used as a mechanism to transfer ambient vibrations into electrical energy. In the proposed paper, focus is on usage of piezoelectric material that could convert the mechanical energy of the person being lost in the environment, to the effective electrical power for the lightening of BRTS stops. This energy can be stored and used to power up electrical and electronics devices. The application of piezoelectric as a power generator can be extended to operate daily low power electrical appliances such as tuner, light bulb, mobile phone and so on. The aim of this paper is to develop the piezoelectric material as a power generator for BRTS stop lightening.

Piezoelectricity

Piezoelectricity is appearance of electric potential across the sides of crystal when subjected to mechanical stress. Thus by making use of human movements and movements of automobiles, piezoelectricity can be generated to a commercially usable extent.

Thus, Piezoelectricity is the ability of some materials (notably crystals and certain ceramics) to generate an electrical potential in response to applied mechanical stress. This may take the form of a separation of electric charge across the crystal.ss

If the material is not short-circuited, the applied charge induces a voltage across the material. The word is derived from the Greek word *piezien* which means to squeeze or press.

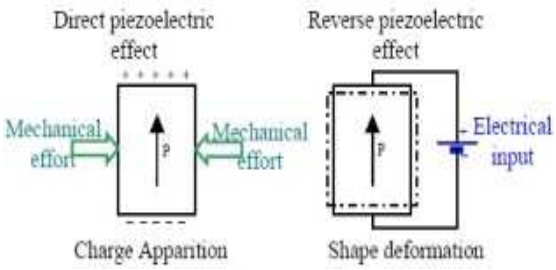

Figure 2: The Process of Electrical Energy Production by Piezo-Crystals

WHERE & HOW TO IMPLEMENT

The main aim of our paper is implement the piezo sheets in the flooring of the BRTS stops, so that the public that would step on the stop for the taking of bus can put up the mechanical stress on the sheet, changing its physical size and producing some amount of electricity.

The tiles of the floor made up of many layers of rubber sheeting, to absorb the vibrations and ceramic; underneath piezoelectric crystals are placed which can be used to generate electricity by movements on them. When such tiles are installed in locations of stops, where large crowd movements are expected and a person steps on them, than by piezoelectric effect small charge is built up on surface of crystals. Though energy generated by one person would be too less but if number of steps on such tiles increase than energy produced by it would increase too. When electric charge is built up on crystal's surface which can be collected by use of electrodes. Such energy can be stored in capacitors and power can be channelled to energy deficient regions.

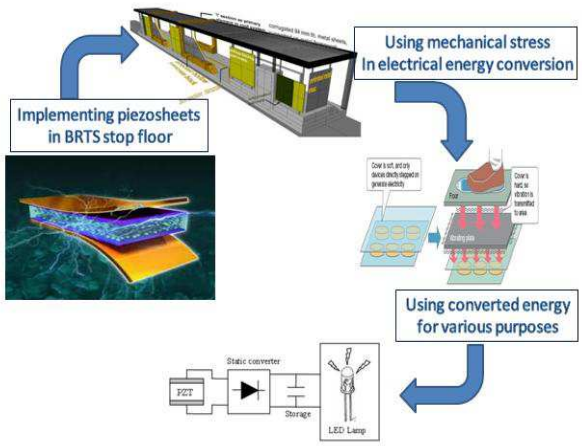

Figure 3: The Implementation of Piezosheets and Utilization of Power Generated

Japan has already started experimenting use of piezoelectric effect for energy generation by installing special flooring tiles at its capitals' two busiest stations. Tiles are installed in front of ticket turnstiles. Thus every time a passenger steps on mats, they trigger a small vibration that can be stored as energy.

The output of the piezoelectric material is not a steady one. So a bridge circuit is used to convert this variable voltage into a linear one. Again an AC ripple filter is used to filter out any further fluctuations in the output. The output dc voltage is then stored in a rechargeable battery.

IMPLEMENTATION ANALYSIS

As we know the pressure is directly proportional to amount of power generated

$$P \alpha Wt$$

Here we take the constant of proportionality as Ķ, then the equation becomes

$$P = Ķ Wt$$

Where,

Ķ- Constant of proportionality

Wt-weight

P-power

We know that for wt=50kg, we get the value of voltage V=4v and I =0.015A

Then P=V*I=4*0.015=0.06w, means we can say that for 50kg we get power

(P) =0.06w

From this we can find the value of Ƙ

Ƙ=P/wt=0.06/50=0.0012

Table 3: Power Generated by the Wieght Applied

SR.NO	PIN WAT	WT IN KG
1	0.012	10
2	0.024	20
3	0.06	50
4	0.09	75

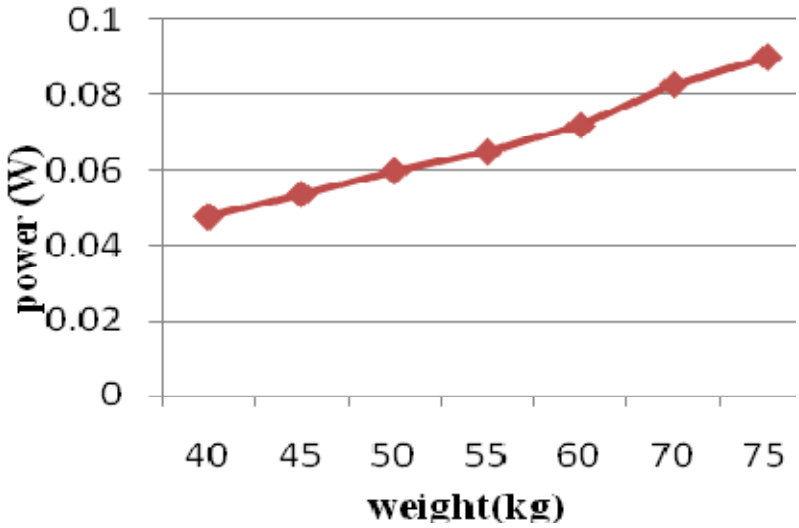

Figure 4: Graph between Weight Applied & Power Generated by Piezosheets

An average person weighing 60kg will generate only 0.8watt In a single second required to take two steps across the tile, But when they are covering a large area of floor space and Thousands of people are stepping or jumping on them, then Significant amount of power can be generated. This energy Created is sufficient to run automatic gates and electronic displays. Cost Analysis

Table 4: The Cost Analysis of Implementation

S.No.	Name of Equipment	Cost (Rs) Per Unit
1.	Piezoelectric sheets (tiles)	550
2.	A.C. Ripple Neutralizer	250
3.	Battery	1500
4.	Inverter	1500
5.	Voltage sampler and other components	2000
6.	**Total coSt**	**5800rs**

- Power Obtained Analysis

Table 5: The Future Power Prediction (Estimated)

S.No	Duratin	Power Generated Initial (50 tiles)	Power Obtained Future (1400 tiles)
1.	Daily	0.34kWh	7.07kWh
2.	Weekly	1.7kWh	35.35kWh
3.	Semester	25.5kWh	530kWh

Piezoelectric able to obtain efficiency above 30% of efficiency depends on method of devices of being used.

Overall cost of this concept is estimated RM 1.4million per Km and year return capital investment is 1.5 years.

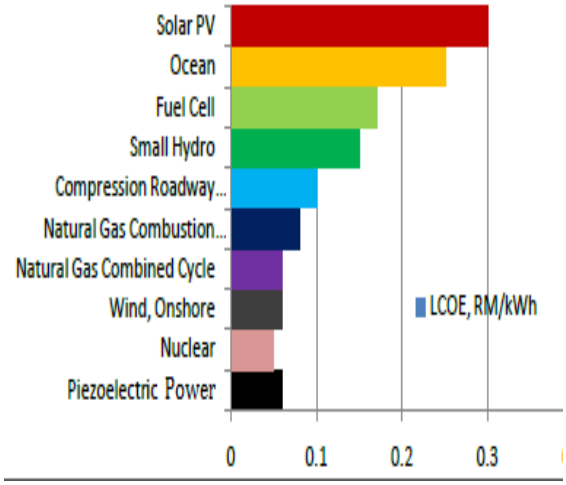

Figure 5: The Graphical Representation of Power Generation by Piezoelectric Materials

ADVANTAGES

- Reliable, economical, eco-friendly.
- Less consumption of non- renewable energies.
- Extremely wide dynamic range , almost free of noise.
- Excellent linearity over dynamic range.
- Compact yet highly sensitive.
- No moving part, hence long service life.
- Self generating- no power required.
- Great variety of models for nearly all purpose.

APPLICATIONS

- Foot step generated power can be used for agricultural, home appliances, street lightening, etc.
- Foot step power generation can be used in emergency power failure situations.

- Metros, railways, bus stands, etc.

FUTURE VISION

While studying use of piezoelectric crystals embedded in shoes and roads, idea struck in our mind that piezoelectric crystals can be replaced with small hydraulic pumps in heels of shoes and large pumps in case of bridges & roads. While stepping such hydraulic pumps at heel of our shoes would get compressed and this compressed air can be used to rotate small electric generators at heel of shoes. Thus our daily movement can be used to run small electric devices. Though such generators would be able to generate small power but on large scale i.e. if used in bridge construction than massive energy can be generated. Similarly by driving on such road & bridge, due to compression the hydraulic pump can to rotate generators in turn generate electricity. Other then that, the future progress in power generation through piezo energy can be seen in.

Residental Area

Energy is transferred to charge battery which can be use or direct use for suitable electronic devices.

Station Generator

Energy is transferred to charge vehicle powered electric battery. Vehicle that arrive to the station can straight away replace full charged battery on the station. This concept act as energy resource station.

Wind Farm at Mountain

Wind farm is good to act as electric power generation where energy is transferred to power station and powered a particular area by network grid. The recommend placed is stated on Malaysia wind rate analysis.

CONCLUSIONS

In this paper, a theoretical model on the generation mechanisms of electricity by piezoelectric material attached to a flexible structure has been developed and tested experimentally. This concept is the big solution for future electric powered vehicle concept and as power generator. Besides this, use of earth's limited source can be reduced too. Even though the power output is not much high, quantity can increase the output as long renewable energy is fully utilized. The piezo-host configuration is then optimized with huge increment in the voltage output. With the configuration optimised, the voltage and current density from the piezoelectric are made high. This project supports the utilization of this force per area power by converting it into electrical energy through the means of piezoelectric effect which is the ability of certain materials to generate an electric charge in response to applied mechanical stress.

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