

Evaluation of the Road User Costs of Non-Conventional Energy Driven Vehicles

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Abstract:

Pavement material is an important factor for creating a pedestrian and environmentally friendly walkway. Generally, kinetic energy of a footstep during walking is mostly wasted, while, this energy can be harvested and converted to electrical power. This study aims to use piezoelectric materials within pavements in the form of tiles. The kinetic energy of walking is harvested through piezoelectric mechanism. The study proposed a pavement consisting of piezoelectric sensors. Flexible and green material is selected as the top layer of the pavement. The scaled prototype is fabricated according to the mechanism of walking. The pavement is tested in terms of voltage generation in different arrangements. The results show that in order to harvest the optimum energy of walking, the piezoelectric sensors need to be covered with a conductive layer such as a steel sheet. It is also found that covering the piezoelectric materials with a hard surface leads to load distribution over the sensors when stepping on it which generates more voltage.

More voltage is generated when the piezoelectric pieces are placed in an alternative arrangement. It can be said that the arrangement of the piezoelectric sensors and their connection to the conductive layer are important factors in harvesting the optimum walking energy. The study recommends that pavement equipped with piezoelectric material is a promising method to generate electricity when implemented in crowded areas.

Keywords —paving; piezoelectric material; renewable energy; kinetic energy harvesting; pedestrian walkway; walking energy.

I. INTRODUCTION

The pavement can serve more purposes than just providing a space for walking. As most of the walking energy is wasted, harvesting and recovering of this type of kinetic energy can add value to the pavement functions as well as providing environmental friendly pavement. Since non-renewable energy resources are gradually depleting, contributing to greenhouse gas emission, and significantly causing climate change, increasing use of renewable energies and sustainable approaches are suggested. Moreover, developing renewable energies can reduce the danger of greenhouse gas emission and sustain the environment. Harvesting energy is one of the most

promising techniques in response to the global energy problem without depleting natural resources. Energy harvested from ambient sources is recognized as an economically practical, environmental friendly, and technically feasible alternative to batteries as a power source. It refers to small power generation systems to supply energy of low power electrical systems. Kinetic, thermal, solar or electromagnetic radiation sources are some examples of ambient energy to harvest. Harvesting energy of people who walk across the floor, in the form of compressive forces, is a sustainable method for producing electrical energy. In this study, energy harvesting technology is incorporated within pavements in the form of tiles in order to recover the wasted energy of walking as a sort of renewable

energy. This harvested energy would be stored in a battery and used for lighting system of the pedestrian walkway. To harvest the waste mechanical energy and to store it in the electronic capacitor, piezoelectric transducers are selected for this purpose. However, pavement design primarily has to apply acceptable engineering criteria and standards, considering human comfort factor helps in providing a pedestrian friendly path. Therefore, this study aims to design a pavement which considered both pedestrians comfort and environmental factor by selecting the best choice of the material. In this paper, firstly, the transduction and system design are described.

II. LITERATURE REVIEW

The study designed a pavement for a walkway that can harvest kinetic energy of pedestrian and provide comfortable surface for pedestrians as well. The proposed pavement tile consists of piezoelectric materials covered with a steel sheet and a rubber layer at the top. The study examined different connections and arrangements of the materials and layers to obtain the optimum condition. The results show that the alternated arrangement of piezoelectric materials when covered with a steel sheet at the top can distribute the loads better and subsequently, generate higher voltage. Moreover, it is also found that parallel circuit is the best option in tiles connection, in which 15 V is generated in a walking cycle of a pedestrian with 50 kg weight. The study recommends that it is especially suited for implementation in crowded areas as most of the kinetic energy of waking people is wasted, even though it can be harvested through an energy-harvested tile.

From the results and the sensitivity studies, it is clear that ERS offers a potential to dramatically reduce the cost of vehicle electrification for a nation if the technology can be deployed at a scale within the investment range and installed. The technology selected needs to be accessible to both heavy and light vehicles, a difficult proposition as the

operators of each vehicle category have different incentives.

Accident records and road tests were considered and abandoned as bases for a criterion of safe driving in the army situation. Observations and judgments of drivers, supervisors, and associate drivers were then considered and an instrument, including rating scales and a check list, was developed for their quantification. A population of 189 drivers was rated on 11 experimental scales by an average of 4*8 supervisors and 12.5 associates. Of the 11, four scales were finally chosen on the bases of (1) reliabilities, (2) correlations with an accident-responsibility index, (3) intercorrelations among the scales, and (4) results of a factor analysis of these intercorrelations. The same raters were asked to indicate, for each of 105 descriptions of unsafe driving habits, how reliable (observable) the behaviour is and how important it is to safe driving. The 15 statements adjudged most reliable and most impairment were selected for the final check list. The mean rating on the four scales receives a double weight and the mean number of checks received has unit weight in the composite criterion score.

The IRTAD Road Safety Annual Report 2019 provides an overview of road safety performance for 41 countries. The report outlines the most recent road safety developments there and provides comparative data for the main road safety indicators. It also offers detailed analysis by road user, age group and types of road. It describes the crash data collection process in IRTAD countries, the road safety strategies and targets in place and information on recent trends in speeding, drink driving and other aspects of road user behaviour.

Accident cost analysis in Bangladesh is still in its premature stage. A good many assumptions had to be made in carrying out the exercise. However efforts are always active to reduce the number of such assumptions and to make the analysis more fact-based. The analysis has proved that accident costs are quite significant in Bangladesh and cause a substantial drain on its resources. As traffic volume and the population increase these costs will

increase more than proportionately. Immediate action is required to address the accident problem in Bangladesh if the scale of the losses is not to persist beyond tolerance and if there is an intention to reduce the loss of human life.

To properly design an eRoad with good service performance in the future, it is important to understand firstly the mechanical response of the structure under typical operational conditions. Therefore, a mechanistic approach suitable for analysing the composite road structure, like an eRoad, is first developed in this research. This approach mainly relies on numerical modelling via the Finite Element Method (FEM) and an advanced finite strain constitutive model for asphalt material.

Project planning

1. RUC analysis for project planning includes the addition or removal of routes to a network.
2. New methodology was proposed to include accident costs in future calculations.
3. Sources of unit costs were re-evaluated and updated.
4. VOT unit costs include the wage rates for South Dakota workers.
5. VOC unit costs include operating and ownership costs.
6. AC unit costs use the property damage equivalent weighted accident rates calculated for South Dakota and the recommended PDO value from AASHTO.

This paper analysed the role of electric vehicles within a lower carbon 2020–2030 new vehicle fleet in Europe. For this purpose, literature data on cost and emissions has been collected, analysed, and aggregated. Based on the collected data, the cost of batteries, fuel cells, and charging infrastructure has been estimated. In addition, power train costs of BEVs, PHEVs and HFCEVs has been approximated using a bottom-up approach. In addition to recent cost declines, power train costs for all three types are expected to decrease further, by 50%–70% between 2015 and 2030. This occurs over the same period as conventional combustion vehicles are having expected cost increases, further

narrowing the gap between conventional and electric drivetrains. As a result, BEVs can break even with ICEVs and even fall below the costs of PHEVs by 2030.

III. CONCLUSIONS

Based on the literature survey, the following conclusions were drawn

1. Parallel arrangement of piezoelectric circuits yields more energy. Hence efficient connection.
2. It has been found that the critical stress/strain locations inside the eRoad lie mainly in the Asphalt regions close to the intersection with the charging unit (CU). This paper provides some important insight and support for the Road's implementation into the practice.
3. New Methodology was proposed that made changes to VOT and VOC and includes AC in Future Calculations.
4. ERS system of transportation stands effective for both light and heavy vehicles.
5. Electric vehicles showed lower emissions of carbon. Thus proved to be ecofriendly.

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In the Present scenario of large population, a Project keeping a relation between technology along with sustainable existence is worth working.

This Project even though at an initial stage has taught the importance of various cost factors that influence the efficiency of a vehicle and in the latter part, minute content about the future trend of transportation.

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