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Development of Self-Contained Power Supply Systems for Traffic Management Equipment

Vladimir Berg*, Anton Vengerov, Albert Brand, Natalya Mostovaya

Tyumen Industrial University, 38, 50 Let Oktjabrja str., Tyumen, 625027, Russia

Abstract:

This article describes the possibility of using self-contained power sources based on piezo-electric technology which converts kinetic energy of the traffic flow into electric which is located in an inner cavity of a speed bump. The purpose is to provide self-contained power supply system for equipment mounted near pedestrian crossings of children's and youths' educational institutions. The article shows theoretical results of calculations of electro mechanic parameters for piezo-ceramics when a vehicle runs over it. We have developed an experimental setup to study the influence of mechanical pulse stresses on piezo-ceramic plates. We presented a design of self-contained power supply source based on piezo-electric technology.

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Key words: Piezoelectric element, traffic and lighting equipment, speed bump, traffic safety, zebra crossing.

1. Introduction

In 2015 the amount of 184,000 traffic accidents happened in the Russian Federation which led to the death of 23,100 people. According to the death rate in traffic accidents the Russian Federation is in top three among Europe and North America. The actions taken such as tightening the laws, mass inspections, roads reconstruction and increase in the number of recording cameras make no effect [Buchakova and Romankova (2015)]. The total amount of casualties in traffic accidents with pedestrians has decreased by only 4% compared with 2014, while running over pedestrians has increased by 2%. The most critical issue is related to 4% growth of traffic accidents with children.

* Corresponding author. Tel.: +0-000-000-0000 ; fax: +0-000-000-0000 .
E-mail address: allbert@mail.ru

According to the data of Traffic Safety Department of the Ministry of Internal Affairs of Russia (State traffic inspection) in 2015 there were 19,549 traffic accidents with children under 18 with caused the death to 737 children (Fig. 1).

Traffic accidents and victim children under 18

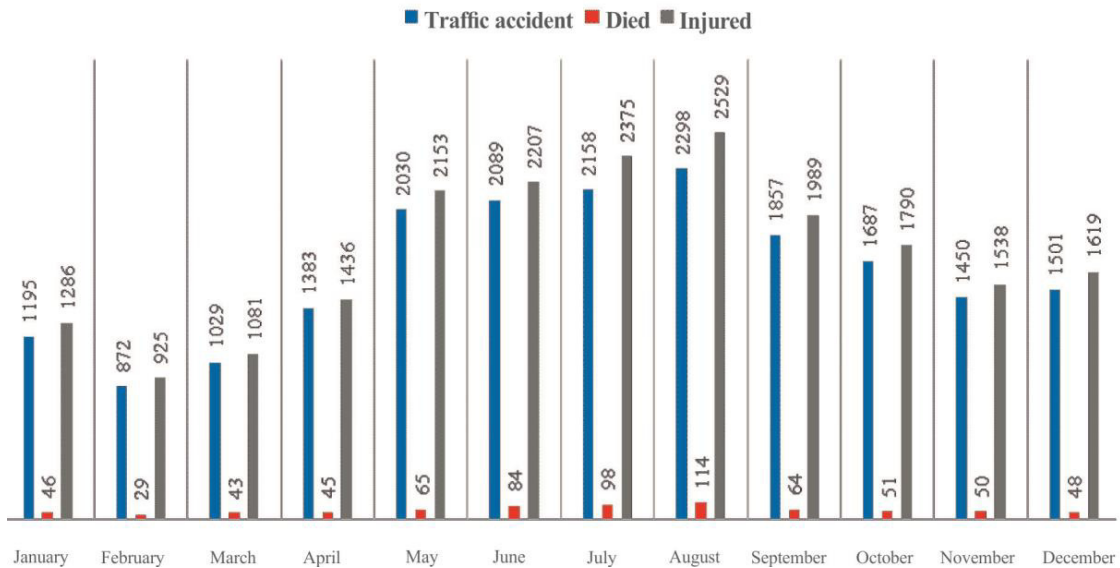


Fig. 1. Statistics "Traffic accidents and victim children under 18" according to Traffic Safety Department of the Ministry of Internal Affairs of Russia.

Comprehensive study of statistics data of the State Traffic Inspection showed that during summer months the number of accidents in pedestrian crossings is growing much higher in the evenings and night time. The reasons of risk growth are: increase in physical activity and mobility in summer, violation of traffic rules by underage pedestrians, cyclists and motor bikers, poor quality of works and growing number of faulty traffic lights, traffic signs and other lighting and signaling equipment due to failure of electric substations and power supply lines [Gusev et al. (2014)].

The number of violations of traffic rules by underage pedestrians can be decreased with the help of preventive discussion campaign, whereas the number of failures of power lines can be decreased only by a good number of technical measures which is possible only if the economy is stable. Local self-contained systems are the most efficient method to increase safety and mitigate the risk of road accidents in pedestrian crossings. So the objective of the study is to develop self-contained power sources for traffic management equipment located on pedestrian crossings in order to reduce the risk of road accidents.

2. Main part

Six national standards were amended and came into effect from February 28, 2014 to improve national standards related to the outstanding issue with safety of pedestrians. The amendments are:

- An amendment in clause 4.5.2.4 of GOST R 52766-2007 "Public roads. Road facilities. General requirements": "A pedestrian crossing shall be equipped with road signs, road markings, stationary outdoor lighting (powered up from distribution networks or self-contained power supply sources",

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