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Original Research Paper

Effect of speed hump characteristics on pavement condition

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HIGHLIGHTS

- Speed humps are randomly placed without engineering studies, in many Egyptian roads.
- Pavement conditions are greatly influenced by speed hump characteristics.
- PCI tends to increase as width of hump and distance between humps increase.
- Height of speed hump showed negative correlation with pavement condition.
- The developed model is very useful for pavement condition evaluations.

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ABSTRACT

Speed humps are the most common type of traffic calming devices due to their low cost and easy installation. However, in many Egyptian roads, considerable number of these humps is randomly placed without proper engineering studies and justifications. Deterioration of pavement condition is observed near these humps. This paper presents a case study applied to collect and analyze visual inspection data for the reason of evaluating the impact of speed humps on pavement condition on intercity rural roads. The paper used 52 speed humps located in an intercity two-lane, two-way road that connects two cities, Tahta and Gerga, in Upper Egypt. The total length of this road is about 34 km. Pavement condition index (PCI), in road sections, near speed humps in the two directions of travel were calculated from the visual inspection measurements. The characteristics of each speed hump (width, height, and distance from preceding hump) were measured. Using statistical analyses, the correlations between the pavement conditions and hump characteristics were examined. Regression analysis models were developed to represent the relationships between pavement conditions and hump characteristics. Generally, the results proved that the pavement conditions are greatly influenced by the presence of speed humps and hump characteristics.

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1. Introduction

Intercity roads in Egypt achieve two purposes: serving through trips, and providing access to commercial, residential, educational and other activities in the adjacent land, as these roads go through villages and semi-urban areas. A dominant factor in these road operations is the presence of speed humps. Speed humps are raised pavements spanning across a roadway, accordingly; forcing drivers to reduce the speed of their vehicles (Bekheet, 2014). Installing of these humps on such roads aims at controlling vehicle speeds in residential areas for safety perspective. However, considerable number of these humps is located outside villages/cities limits, where there is no justification of controlling speed at such open areas. Also, in most cases, they are randomly installed without uniform engineering studies where no particular design and occasionally no proper signage and markings are used.

Moreover, these speed humps are sometimes constructed in a manner that may cut the water path over the pavement surface (Bekheet, 2014). The presence of such humps has a negative impact on roadway level-of-service, as they increase travel time and delay. They also may cause serious damages to vehicles and passengers, and increase fuel consumption and pollution. Moreover, these improper speed humps may deteriorate the pavement condition, before and after the location of hump, due excessive acceleration and deceleration movements, and might be a factor in reducing the pavement service life (Hallmark et al., 2002).

Consequently, there is an urgent need to investigate the impact of speed hump characteristics on pavement condition, in order to assess how much they contribute to the pavement deterioration of intercity roads dominated by speed humps. Therefore, this paper presents a practical study to collect and analyze visual inspection data for the reason of evaluating the impact of speed hump characteristics on pavement condition. The visual inspection data are carried out or collected by field survey for pavement distresses which is characterized by pavement condition index (PCI). Fig. 1 represents an example of studied road humps.

For the reason of evaluating the impact of speed humps (width, height, and distance from preceding hump) on pavement condition, an intercity two-lane, two-way road that connects the capital city of Sohag, with the commercial cities, Tahta, Gerga in Upper Egypt was used as a case study.

Fig. 1 – Example of study road humps.

According to the main objective of this paper, which was stated earlier, a detailed statistical analysis is carried out to examine impact of speed hump characteristics (width, height, and distance from preceding hump) on pavement condition. More specifically, the analysis is carried out for the following reasons.

- To investigate the impact of different speed hump characteristics on pavement condition.
- To develop statistical relationships between pavement condition as a dependent variable and speed hump characteristics as independent variables.
- To present the best developed relationship in a form (e.g., graph) that can be easily used by highway and traffic practitioners to examine the pavement conditions of existing road pavements or to compare the expected pavement condition of other alternatives.

This paper consists of six sections. In the next section, a literature review section, speed humps and impact of speed humps on different variables, will be introduced. Moreover, the fundamentals of pavement condition index (PCI) were provided. Section 3 describes the case study for a highway that contains 52 humps. Section 4, discusses the correlation and regression statistical analyses between PCI and speed hump characteristics. Sensitivity analysis are presented in Section 5, and conclusions and recommendations are drawn in Section 6.

2. Literature review

2.1. *Speed humps*

Traffic calming is defined by the Institute of Traffic Engineers (ITE) as "the combination of mainly physical measures that reduce the negative effects of motor vehicle use, alter driver behavior and improve conditions for non-motorized street users" (Faheem, 2011; Lockwood, 1997). The objective of traffic calming is to reduce the speed and volume of traffic to acceptable levels for increasing the safety of the roadway (Ewing, 1999). Traffic calming devices, such as speed humps, speed bumps, speed tables, roundabouts, transverse rumble strips, optical speed bars, textured pavement, and cat-eye reflectors, are spreading across Egypt, while speed humps and cat-eye reflectors are the most common (Faheem, 2011).

Speed humps are rounded raised areas of pavement with parabolic, circular and sinusoidal cross-sectional shapes. They are the most common type of traffic calming devices due to their low cost and easy installation. The most common design of speed humps is the Watts Profile or circular hump. Most vehicles can traverse them safely at 25–30 km/h. Speed humps are designed to create a rocking motion that increased driver discomfort as crossing speed increased (Faheem, 2012). A speed hump is a local elevation of the road surface of limited length. Normally, speed humps are 3.70–4.25 m in length and up to 0.15 m in height. On an exception basis, humps may be shorter or longer than the typical design. The lengths and heights of the humps determine the speed at which traffic will travel over them. Shorter lengths and greater heights

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