The Effectiveness and Evaluation of the Implementation of Low Cost Engineering Measures at known Black Spot

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Abstract

Usually accidents are concentrated on some locations more than others. These locations are called "Black Spots". A number of these locations can be identified on the Jordan road network. These locations should be identified, and special attention should be given to them to understand the causes in the increase of traffic accidents. Then remedial measures identified and applied to contribute to the reduction of traffic accidents.

One of these locations selected in this study is on the International Road between Syria and Jordan known as "Thagrat Aljob". This location is characterized by a high percentage of traffic accidents. It is an area that links two highly populated districts; Zarqa and Mafraq, accidents occurring at this location were characterized by a high number of fatalities and injuries.

The Ministry of Public Works and Housing (MPW&H) has introduced a number of engineering countermeasures at different locations, and yet these did not reduce the number of accidents or their severity.

However, the aim of this study is to analyse accidents occurring at the study site, "Thagrat Aljoub", their causes and severity, and to identify engineering countermeasures as well as studying the failure of some of the measures applied by the MPW&H. in addition, the paper will recommend engineering measures to be applied in order to reduce traffic accidents at the study site.

Key words: ***Traffic Accidents, Traffic Safety, Black Spots, Fatalities, Engineering Countermeasures***.

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Introduction

Nowadays, road accidents represent one of the major causes of death and injury. The fatality rates per licensed vehicle in developing countries are very high in comparison with the industrialised ones [1]. Apart from the pain grief and suffering of those involved in road accidents, is the accompanying annual economic loss to all countries, and yet despite the daily tragedy and the economic losses there is still a sad lack of concern for road safety among the public, engineers, planners and politicians [2]. Road accidents could be classified into different classes on the bases of their severity, type of collisions, location, involvement of the vehicles and their types, the road environments, and the contributing factors. Counter measures could be aimed at the type of collisions such as pedestrian accidents, rear end and angular collisions etc. Other measures could be directed to reduce the accidents severity (fatal, injury accidents), or the analysis may concentrate on the accidents occurring at certain types of locations like junctions, curves, roundabouts or major highways. Some solutions may be directed towards night time accidents or on the type of vehicles involved like motorcycle accidents, transits vehicle or the public transport vehicles.

Economical cultural and social developments of Jordan, and the population growth led to the increase of number of vehicles. The rate of increase in vehicle numbers was not associated with an equal rate of road construction and modification of road infrastructure. This has led to increase in number of road accidents which has led to increase of fatalities and injuries, which were accompanied with economical losses. In spite of these losses, there is still a sad lack of concern for road safety among the public, engineers, and planners.

Causes of Accidents

One of the first steps towards road safety is to understand the nature and causes of accidents, not only the general known causes (human. road, environment and vehicle.) but also specific local conditions that aggravate road safety. This means that accurate and reliable data about road accidents is to be compiled, analysed and interpreted. Generally traffic accidents are attributed to three major factors. The first one is human factor, which might be due to distractions, perceptual errors, misjudgement of distances and the road situation ahead, and physical impairment (under the influence of alcohol, drugs or illness). The second factor is the road and its environment which might be attributed to deficiencies in design, construction and/or maintenance of road. While the third factor is

the vehicle condition that is due to mechanical faults, defective brakes, bald tyres, and poor maintenance of the vehicle [3].

The study will be based on the technique of identifying and treating black spots. In spite of the fact, that more than 90% of accidents in Jordan are attributed to human error. This implies that the education and training of road users needs to be reviewed and strengthened. However, in reality engineering measures are the main solution to black spots, as it is easier to influence human behaviour through engineering measures than by education and training.

In a study by Jacob and Sayer (1983) [4], it was estimated that road accidents cost 1% of GDP for developing countries; hence, the total cost of the engineering measures will be calculated. Then by finding the cost to benefit ratio the most cost effective measures can be determined.

There are many approaches to accident reduction; in this study the treatment of single sites, like junctions, short lengths of road or curves etc, which are considered to be black spots due to an accident cluster will be adopted. The study will also include the monitoring and evaluation of these sites.

This is carried out by adopting before and after treatment which is simply a comparison of all the accident numbers, characteristics and their frequency at the specific sites, before and after the engineering measures have been implemented.

Objectives

The aim of this study is to identify counter measures to be taken to reduce the number and severity of accidents at the study site. This can be achieved by analyzing accidents at the site before and after the implementation of engineering measures during the study period. Then effectiveness of counter measures presently taken by Ministry of Public Works and Housing (MPW & H) will be evaluated. Then, the most effective and low cost engineering measures will be recommended.

Site Description

The study site is called "Thagrat Aljob" it is located on the International Road between Syria and Jordan between Stations (30+500) and (33+000). It is a four lane highway (two lanes in each direction) divided by a median. The black spot area consists of a combination of vertical and horizontal curves. The slope of the vertical curve is 6% and the radius of the horizontal curve is 500m with a super elevation of 7.5%. Therefore, both

vertical and horizontal curves meet in this section, Figure 1. The topography of the site is mountainous and the road cuts through rocky terrain which effects the sight distance negatively, Figure 2.

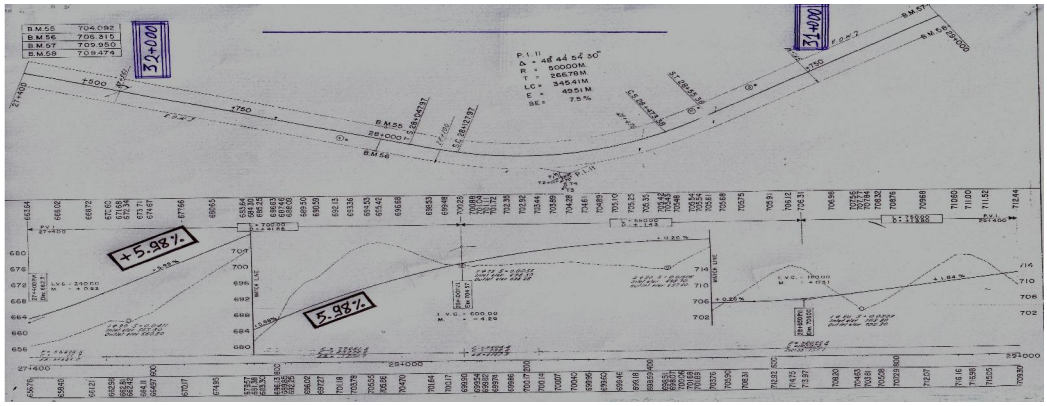

Figure 1. Design plans for the study site between Stations 31+000 and 32+100.

Figure 2. General view of the study site.

The study site is a known "black spot". Being located on the International highway linking two highly populated districts - Zarqa and Mafraq - accidents occurring at this location were characterized by there severity. Fatalities and injuries being higher than the national average rate.

Accident Analysis.

Table 1 below shows the number and type of accidents, injuries and fatalities that occurred at the study site between 2004 and 2007. Vehicle types involved in these accidents were passenger cars, buses, medium and heavy goods vehicles. Within the study period a total of 25 fatalities and 49 injuries occurred at this site.

The accidents shown in the Table below were reported by traffic police, which include fatalities, and injury accidents. Damage only accidents were not reported.

The high severity of these accidents was as a result of high speed over 100km/hr, as reported by the police. This is higher than the speed limit set at this section.

Table 1. Number of accidents, injuries and fatalities that occurred on the study site between the years 2004 and 2007

Year	Number of Accidents			Number of Injuries		Number of Fatalities
	Collision	Run Over	Roll Over	Minor	Major	
2004	15	0	2	2	0	**5**
2005	16	0	3	3	2	**5**
2006	13	0	2	24	13	**13**
2007	15	0	2	3	2	**2**
Total	**59**	**0**	**9**	**32**	**17**	**25**

Another contributing factor could be due to the topography of the site; sharp vertical and horizontal curves, which in turn reduce the sight distance. This is particularly dangerous for drivers unfamiliar with the area (non-commuters)

North – South Bound highway

As mentioned earlier the road is a four lane highway separated by a median.

The majority of fatal accidents were occurring on the down grade sides which could indicate low friction of the road surface particularly at high speed.

Another possible explanation for this is that just before the black spot the road is straight and level encouraging drivers to speed up. The driver is then suddenly faced with a sudden change in direction and gradient (horizontal & vertical curves) without warning.

The sudden change in alignment (short sight distance) steep slope, speeding and super elevation were identified as the main causes of accidents at the site.

The analysis showed that the main features of these accidents were divided into three main categories:-

1) Collision with the median and side barriers.
2) Vehicles crossing to the opposite side and colliding with on coming traffic or the embankment on the other side of the road.
3) Vehicles swerving off the road leading to loss of control resulting in leaving the road and rolling over. This could be due to the loss of friction or the rise in banking (super elevation is incorrect).

South – North Bound highway.

Regarding traffic running from south to north, vehicles travel up a 2.8% slope before reaching a 6% slope, beginning at a vertical curve at the study site. This causes many to drop their speed considerable, i.e., the length of the vertical curve is longer than the critical length.

This sudden drop in speed of trucks and heavy goods vehicles can cause rear end collisions and a loss of control for smaller vehicles and passenger cars.

Also trucks driving at low speed at horizontal curves can cause sliding side ways, particularly if the super elevation is high.

Remedial Actions at this Site

In 2004 MPW&H took the following actions to reduce number of accidents:

a) Reduced the speed limit on this sight from 100 km/hr to 80 km/hr.
b) Installation of warning signs that informs drivers that they are entering dangerous area.
c) Maintenance of damaged side barriers.

These actions were not effective enough to reduce accidents; therefore in 2005 the following remedial measures were taken:

a. Installation of humps from 15*15 cm aluminium studs placed in three rows each 50 m apart.
b. Installation of barriers on the middle island.
c. Installation of extra large size traffic signs informing people that they are entering a hilly and dangerous area.
d. A new asphalt concrete good quality layer was placed on top of the older surface layer.

Even these actions were not effective in reducing the number of accidents on this section, but they were capable of reducing accident severity.

Conclusions:

This study concentrated on evaluating the safety conditions at a location which is located on the International Road between Syria and Jordan, called "Thagrat Aljob". This location is characterized by the high percentage of the traffic accidents. In spite of the fact that the Ministry of Public Works and housing has performed a number of different engineering countermeasure at different courses of times, but these countermeasures were

not enough to reduce the accidents to an acceptable limit. Therefore, the following actions have to be taken at this site:

1- Study the possibility of constructing climbing lane in the uphill direction and an escape lane for the down hill direction.
2- Increase sight distance by;
    a) Widening the curve at the study site.
    b) Cutting the rocks and removing any obstruction.
3- Continuous auditing and monitoring of the site.
4- Increasing the use of compulsory traffic signs.
5- Increase the use of transverse humps using either aluminium studs or asphalt concrete of 20 cm width and of 3-5 cm height. Asphalt concrete humps are preferred over aluminium studs because they will last longer.
6- Study the possibility of removing the median island in this area so that extra lanes can be added in both directions. Directions can be separated by concrete New Jersey barriers.

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