What is the impact of road safety on the design and management of road networks?

Business, Management

Abstract

Road transport is the most common type of transportation worldwide, which inevitably means that traffic accidents, and resulting casualties, are a regular occurrence. Further, the manufacture of cars in recent years, which combine high-speed engines with poor road performance, has a direct correlation with the occurrence of accidents. Consequentially, road safety has become a common interest within all countries throughout the world. In my opinion, road safety can be improved by incorporating relevant geometric, climatic and physical considerations in the design of roads. In addition, the application of an awareness program ineducationand advertising plays a significant role in strengthening road safety and reducing accidents. On the basis of the foregoing, when one is building a safe road, every factor of safety should be taken into consideration and at every stage of the process, including design.

The main objective of this report is to show the impact of road safety considerations in the design of roads and the management of the road network, and how the aim of decreasing road traffic accidents and casualties influences geometric design, traffic design and structural design in road construction. In particular, geometric design and traffic design are greatly influenced by road safety standards, as evidenced in the geometric design of roundabouts, junctions, and pedestrian and cyclist highways. By relying on a specificcase study, this paper will also investigate roundabout design and its interrelation with road safety; for instance, whilst roundabouts are likely safer than intersections because they encourage a reduction in vehicles

speed and conflict points, it has been found that roundabouts with signalisation are safer for both cyclists and pedestrians. For these reasons, it is clear that the improvement of road safety requires the inclusion of safety in road design and management procedures.

Introduction

The road network is a systematic structure, which is constructed on invariable criteria for the purpose of road transportation and designed with certain considerations (such as traffic, climate condition and theenvironment) in mind. It is used by the majority of people worldwide, which is unsurprising considering the volume of traffic accidents and road related deaths and injuries. Indeed in recent times, this is often seen as a global phenomenon, with the number of road related deaths ranging from between 0. 75 and 0. 8 million annually[1]. Unfortunately, it also appears that this number is increasingly rising; indeed, a 2008 publication of the WorldHealthOrganisation (“ World health statistics”) estimated that the death rate from traffic accidents globally is 2. 2%, and that due to the manufacture of car engines capable of higher speeds and the development of the economy in developing countries, it is anticipated that this figure will dramatically increase to about 3. 6% by 2030[2]. Likewise, road traffic accident costs are expected to increase.

There are three main factors which contribute to road traffic accidents: “ road and engineering deficiencies; road user errors (“ human factors”); and vehicle defects”[3]. Indeed, a UK study from the 1970s demonstrated that

the human factor plays an unfavorable role in 95% of accidents, whilst 28% and 8% of accidents are at least partly caused by environmental and vehicle shortcomings[4]. For these reasons, it is not logical to focus solely on one single factor. It is clear that the fact that road user errors feature in the majority of accidents proves that the human factor is the principle cause of traffic accidents; however, if the construction of roads was geometrically improved, this may not be the case. Indeed, according to Restructuring road institutions, financeand management engineering[5], engineering is one of four factors that influence road safety (along with enforcement, education, and climate). By focusing on the impact of the engineering factor on road safety improvement, the objective of this report is:

To demonstrate and define the concept of road safety.
To explain the incorporation of safety features in road design and management.

This report consists of 6 parts: methodology; an explanation of road safety, road design, and road management; the impact of road safety factors on the geometric design and management of roads; a presentation of a case study on road intersections, cyclists and pedestrian safety at roundabouts; a discussion; and finally, a conclusion

2. Methodology

To demonstrate the effect of the road safety considerations on road design and management, this paper will investigate road intersections through a

case study linked to geometric design, and then discuss the safety of cyclists and pedestrians in relation to roundabouts. See Figure 1.

3. Road safety

According to Oxford Wordpower Dictionary[1], safety is defined as “ the state of being safe; not being dangerous or in danger”, whilst road safety is defined as “ the prevention ofroad accidents”. The purpose of roads is to provide facilities for safe travel and transport, and improved road safety can be achieved in the design and management of road management by incorporating safety orientated “ design criteria, design values and interventions”[2]. Such an approach could not only lead to a decrease in road related deaths and accidents, but it could also make roads more accessible. Indeed, as outlined in the DTMRQ manual[3], such an outcome can be achieved with the application of certain factors:

Improving road network safety using a risk management approach;
Designing for safer travel for all road users;
Providing safer access to the road system for cyclists and pedestrians;
Ensuring work site safety; and
Co-ordinating with other government agencies in partnership.

As stated above, road users errors is the main factor which contributes to road accidents. However, it has been observed that the enhancement of engineering design and management can influence drivers’ behavior positively and reduce the number of such errors[4]. It should be noted that no road is absolutely safe and that the safety of a road is often measured on

the volume of accidents on it. For that reason, it is logical to indicate that the construction of a road involves the use of a nominal safety level[5]

4. Road design:

According to Oxford Wordpower Dictionary[6], design is defined as “ to plan and make a drawing of how something will be made”. The three aspects of design that must be considered in the construction of roads are geometric design (which relates to physical elements such as “ vertical and horizontal curves, lane widths, clearances, cross-section dimensions, etc”[7]) traffic design and structural design. Good road design standards involve a combination of these three variable aspects to produce efficient and safer road.

4. 1 Geometric design:

Road geometric design involves horizontal and vertical alignment and road cross-section, with the determination of these elements based on the criteria of road safety[8]. The reduction of the road accident rate is significantly influenced by these elements meaning there is a clear relationship between road design and road safety. For example, it has been found that junctions that are geometrically designed with road safety in mind see a smaller number of road accidents. Sound geometric design can involve a reduction in the number of conflict points (with the construction of channels). Indeed, it has been found that the use of roads with two lanes, which are each 3. 7m wide, are safer than roads with one lane that is 2. 7m wide[9]. In addition, it is felt that the presence of the median reduces the cross-median accident

rate, even where it is narrow, and that the inclusion of safety fences at the outer edge of roads plays a significant role in road safety[10].

Road Management:

According to Robinson (2008)[11], road management is defined as “ a process that is attempting to optimise the overall performance of the road network overtime”. This involves action that affects or can affect the road network quality and efficiency during the service lifep and which facilitates trade, health protection, and education by enhancing accessibility. Further, the improvement of road efficiency, effectiveness and safety can lead to increasing economic well-being as a result of lower commodity prices. Road management is affected by a number of factors, but the dominant is “ accident levels and costs”, which is directly related to road users and economic infrastructure[12]. As a consequence, road management action can involve the policing of vehicle speed in order to improve safety. Additionally, it can also include such activities which are conducted on the road itself and the surrounding environment, such as road maintenance. As Robinson (2008) states, the aim of road maintenance is to make roads safer because it contributes to the geometric factors in the areas of:

Pavement and footway surface;
Carriageway marking and delineation; and
Signs, street lights and furniture.[13]

In this way, road safety can be incorporated in road management; for example, the continuous repair of pavements reduces vehicle operating costs to be reduced and the rate of accidents on the road.

Road intersections

Road intersections are a significant part of the road network structure, and in spite of their simple function, they contributes more than 20% of fatal road accidents in the EU[14]; and even though it has been reported that about 31% of serious accidents occur in non-built-up areas, 65% occurred at built-area junctions in1984in the UK[15]. According to the Federal Highway Administration (2006)[16], road intersection safety has become a considerable problem in the USA because more than 45% of approximately 2. 7 million crashes that occurred there in 2004 happened at junctions. Unfortunately, despite the fact that junction design and traffic standards have seen a significant improvement generally, it has not caused a significant reduction in the rate of accidents per year. For those reasons, the FHWA supported the concept of converting intersections to roundabouts in order to decrease the rate of accidents and to provide increase safety.

Rate of fatal casualties in EU at junctions and other locations of roads

Case study

A study was carried out in 8 States of the USA in 2004 for 24 junctions before and after conversion to roundabout. It resulted in a 39% reduction of overall

crash rates, with a 90% and 76% reduction in the fatal and injury crashes, respectively[1]. See Table 1.

Reduction of crashes following roundabout conversions at 24 U. S. junctions

In 8 states in USAReduction In Crashes %

In 2004OverallFatalInjury

-39%-90%-76%

Table 1: the information from FHWA, 2006

Discussion

The reduction in the level of road traffic accidents in the case study proves that replacing junctions with roundabouts is the logical decision in the USA because it is clear that such a course of action increases overall safety. Unfortunately, the study sample is small as it does not cover all safety aspects, and the safety of the cyclist and pedestrian is not clarified because the crashes categorized are only based on motor vehicles. It should be noted that approximately 75% of cyclist accidents occur at roundabouts[2]. For that reason, the impact of roundabouts on passengers and cyclists is worthy of investigation.

8. 1 Roundabout and road design

According to Fortuijn (2003)[3], the majority of cyclist-car accidents occur when a cyclist is circulating in the roundabout and a car either enters or exits from the roundabout. It has also been said that roundabouts that are charactarised with a significant design feature (e. g. a requirement to reduce

vehicle speed to 30phm, use of a central island, a right angle connection between roadways and circular roadways, or a right of way traffic movement) serve to reduce crash rates and cyclist accidents. Another characteristic that improves road safety at roundabouts is the reduction of conflict points to about a quarter of the number utilised at other junctions.

8. 2. Roundabout and road management

Modern roundabouts are recognised with high capacity, low speed, and non-use of signalisation. The use of roundabout signalisation is typical dependant on traffic volume and safety. Nevertheless, the roundabouts that don’t use signalisation are still safer than junctions[1]. Further, the maintenance of traffic signs, lights and pavement surface serve to increase road life service and safety.

The manufacture of vehicles with higher speed engines may serve to reduce the efficiency of roundabouts and increase the safety hazards to cyclists and pedestrians, especially at times of high traffic volume. According to the findings of the London Road Safety Unit (2003)[2], the roundabouts with signalisation are safer for both cyclists and pedestrian, based on a study which was conducted in 2003 for a number of roundabouts, before and after signalisation

Conclusion:

This report has sought to demonstrate the impact of road safety in design and road management by defining and analysing the relevant concepts, with

particular attention paid to cyclist and pedestrian safety. The following points were also concluded:

Road accidents occur due to three main factors: road users, environment and engineering.

The level of road safety measures that are utilized depend on the volume of accidents.

Road safety is incorporated into road design and management through incorporation of safety considerations.

Road safety is improved through road maintenance.

Roundabouts typically serve to reduce vehicle speed and conflict points, which in turn can reduce the road accident rate, and increase the safety of cyclists and pedestrian.

It is believed that the road design and management plays a significant role in road safety enhancement through the interaction of safety criteria with the road efficiency.

Signalisation at roundabouts can increase the safety of cyclists and pedestrians, and a cyclist right of way can reduce the rate of car-cyclist accident

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