

Review: Asphalt Pavement Rutting Distress and Affects on Traffics Safety

Ahmed Samah Shyaa and Ir Dr Raha Abd Rahma

Department of Highway and Traffic Engineering, Faculty of Civil Engineering and Environmental, University Tun Hussein Onn Malaysia, 86400 Parit Raja, Batu Pahat, Johor

Abstract: Highway is an essential facility that led to both economic success and quality of life. Maintenance is necessary to ensure that highway will able to continue to carry out its functions. The rutting of asphalt pavement structures during their exploitation is considered to be one of the main problems in the entire world. This kind of pavement distress makes a negative impact to the exploitation characteristics of the asphalt pavement to the residual life of pavement structure, also to the safety and quality of the traffic. The main purpose of this review is to define the effects of rutting on roads safety.

Key words: Pavement distress, rutting ,safety.

1. Introduction

Because of the rapid wear off of the highway pavement is promised with the rapid grow of population and traffic volume,. High level of pavement distress will lead to lower riding quality [1], vehicle damage, and more seriously, traffic accident. In recent years, the quality of many of the major trunk roads in the country has been compromised, as the roads have experienced deterioration, which has given rise to the need for periodic maintenance and rehabilitation [2]. One of the major types of distresses observed on major sections of the trunk roads is permanent deformation in the form of rutting. Performance of roads with regards to ride-ability and roughness is known to have a considerable cost implication to the road users in terms of operational cost, in addition to affecting their safety and comfort [3]. Permanent deformation, in this regard has a detrimental effect. Rutting in paved roads can be attributed to various factors such as the pavement structure, quality of individual constituent pavement materials, magnitude and regime of loading, environmental factors, such as moisture temperature,

and others [4].

2. Literature on Traffic Accident Related to Pavement Distresses

Different research has been done concerning traffic accidents in different perspectives, such as highway geometrics, vehicle condition, driver condition, and traffic condition. However, relatively less research on traffic safety related to pavement distress was conducted [5]. A comprehensive search of the relevant literature on traffic accident related to pavement distress shows that the previous studies can be divided into experiment studies and simulation studies [6] . The study of pavement distress safety could not be done in a state wide scale before 1990s because of the difficulties in pavement distress data collection. Professional drivers were always used to perform a series of driving tests on the roadway, and then the professional drivers were asked to evaluate the difficulties of driving on the specific pavement distress.

Due to the professional drivers' skills, there might be bias of their evaluations since their professional judgment may not represent the ordinary drivers. At the late 80's and early 90's with the development of

Corresponding author: Ahmed Samah Shyaa.

advance computer, simulation model can be easily done by computer, and studies such as the simulation of passenger vehicle and truck response to pavement edge were performed [7]. However, literatures on the relationship on traffic accident frequency and pavement condition are limited, and previous studies were more focused on specific safety issues corresponding to a certain type of pavement distress such as pavement/shoulder drop-off, rutting, and pavement roughness.

2.1 Rutting Definition and Causes

Rutting is a longitudinal surface depression in the wheel path accompanied, in most cases, by pavement upheaval along the sides of the rut. Pavement rutting which results in distorted pavement surface is the accumulation of permanent deformation in all or a portion of the layers in a pavement structure. Longitudinal variability in the magnitude of rutting causes roughness [8].

Water may become trapped in ruts resulting in reduced skid resistance. Increased potential for hydroplaning and spray that reduces visibility. Progression of rutting can lead to cracking and eventually complete disintegration. Repetitive application of heavy trucks with increasingly high pressure tires drives rut formation in high quality layers.

The stresses induced near surface layers by the high pressure tires may exceed the ability of the materials to resist densification below critical void levels and subsequent densification. Rutting can occur in all layers of the pavement structure and generally results from lateral distortion and densification. Moreover, rutting represents a continuous accumulation of incrementally small permanent deformations from each load application [9].

2.2 Mechanisms of Rutting

In the initial stages of trafficking, the increase of irreversible deformation below the tires is distinctly

greater than the increase in the upheaval zones. Therefore, in the initial phase, traffic compaction or densification is the primary mechanism of rut development. After the initial stage, the volume decrease below the tires is approximately equal to the volume increase in the adjacent upheaval zones. This indicates that most of the compaction under traffic is completed and further rutting is caused essentially by shear deformation, i.e., distortion without volume change. Thus, shear deformation is considered to be the primary mechanism of rutting for the greater part of the lifetime of the pavement [10].

If the asphalt pavement structure is weak and large stresses and strains are induced in all the pavement layers under heavy wheel loads, initial densification and subsequent shear flow can be developed in various pavement layers. Under such a situation, all pavement layers contribute to total surface rutting of the asphalt pavement. The rut depth under the wheel paths will be the sum of the permanent deformations of all the pavement layers.

2.3 Rutting Identifications and Reducing

Two stages of rutting are identified – firstly consolidation and secondly shear deformation. Consolidation is categorised into two phases: that which takes place during construction and that which continues to take place under the action of traffic. Compaction methods for the preparation of laboratory samples should replicate the summation of both these effects for realistic assessment of engineering properties. Recommendations are made in this respect. In addition the effect of mix component characteristics such as aggregate interlock and the viscosity and temperature susceptibility of the binder-filler mastic are examined and indications given on how the composition can be optimised to render the mix rut resistant.

- To control rutting we must now the following :
- Degree of initial compaction
- ✓ Material properties:

- ✓ Binder absorption by aggregates
- ✓ Aggregate surface characteristics
- ✓ Aggregate grading
- ✓ Binder/mastic temperature-viscosity relationship
- ✓ Binder susceptibility to age hardening
- ✓ Mix design:
- ✓ Binder content and film thickness
- ✓ Voids in the mineral aggregate

3. Methods of Design

More options must to use like method of design by superpave mix design because have more reflected tests in this method of design in real constructed asphalt pavement.

Asphalt mix design should not be done in isolation. The mix designer should have a clear understanding of the particular conditions at the site where the mix is to be applied before selecting the most appropriate mix type to suit the site requirements and initiating the mix design process. The type of information that the designer would typically require upfront includes: the layout of the site (e.g. gradients, intersections, lane width); traffic information (e.g. traffic volumes and composition, operating speeds, directional/lane distribution); climatic conditions e.g. air pavement temperature data, expected month of construction, rainfall, layer thickness, pavement composition and particular requirements imposed on the mix (e.g. skid resistance, noise reduction).

3.1 Rutting Facts Versus Road Safety

The effect of rutting on road safety is an extremely complicated and much debated topic. Experience suggests that deep ruts can reduce vehicle control leading to crashes and so the effect is negative. On the other hand, deep ruts over an extended area may have a positive effect as drivers are forced to reduce speed in order to keep the vehicle under control, and as a consequence, the number of crashes reduces.

Hydroplaning occurs only where there is enough

water ponding on the road to separate the tyre from the road. Improper road drainage, collected water in the wheel path ruts, or extremely heavy downpours may provide this necessary depth of water on the road. Sag vertical curves are particularly susceptible to water accumulation from flows on the two downgrades. At the bottom of the sag vertical curve, a thick film of water may result, presenting a serious hydroplaning hazard.



Fig. 1 Severe mix rutting.



Fig. 2 Mix rutting.



Fig. 3 Outside wheelpath rutting

3.1 Reality of Rutting

The cause of care of large fluctuations is that ruts which are not deep are hardly visible to the naked eye and so can catch the driver unaware, leading to loss of control. However, deeper, clear and more visible ruts make drivers reduce their speed significantly, which in turn it will contribute in mitigates the risk of a crash. The maximum risk of a crash was found to occur for 3mm rut depth on dry road surfaces and for 6mm rut depth on wet surfaces. Also the risk of a rut-related crash was found to increase by 20% to 30% on wet road surfaces in comparison to dry surfaces.

4. Discussions

The most important aims of information technology for road users come out the continuous development of communication systems for road traffic safety improvement has become one of Risk factors detecting and informing drivers about them is contributing in make the transportation system more safe and comfortable.

Unfortunately some of researchers and governments institutions do not cover the real situation of the rutting, its biggest problem that asphalt pavement faced during service life after construction or after little years, to overcome like these errors must have strong leadership of government institution first because it will affect directly on the decision making and Quality control on the all parts of Construction contracts also observing and search for last updates and methods of asphalt constructions methods and mixes design technologies to save time and money and get more serviceable asphalt pavement lines.

5. Conclusion

The primary objective of this review was to understand the relationship between pavement distress and the frequency of accident occur in order to develop pavement management strategies that may reduce the frequency of pavement-related accidents. This review intended to provide interested to the

readers with the significant information about rutting and how to reduce traffic accidents caused by rutting distress, the greatest problems facing the roads constructions today. To improve the resurfacing process to reducing accidents must discussing with state inspectors and contractors found agreement of areas which could be changed Most of the comments dealt with the general areas of contraction preparation of the road prior to paving and as methods to reducing traffics accidents one of solutions is placing the shoulder wedge, and improve the paving operation and compaction processes most effectively and cheap in the same time.

Recommendations

1. Take care about prior roads constructions processes starting especially for subgrade and road base layers.
2. Observe construction processes by experts engineers.
3. Cover all annual accidents data for these area needed for pavement replacing and find suitable solution before laying new asphalt layer and add shoulders to sides of road.
4. Add modifiers to the asphalt mix or binder to resist the rutting and other asphalt distresses.
5. During construction, take care of compaction processes.

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