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Investigating the impact of preventive maintenance treatment practices on pavement performance

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Abstract:

Pavement maintenance strategies have become a significant study field in the 21st Century. Maintenance practices are defined as all procedures that can be taken to resolve all possible deterioration forms. This paper basically attempts to examine the relationship between preventive maintenance treatment practices and the overall performance of the pavement. The researcher followed the descriptive method by reviewing various studies and researches in this field. The study clarified that there are several classifications of pavement types and the main types are (Flexible and rigid) pavements. The study also clarified that there are various factors influenced the overall pavement performance, such as construction quality, moisture level, subgrade, traffic load and maintenance. The main results of this study are:adding the proper type of maintenance at the right time could lower the expected rehabilitation cost and enhance the pavement efficient performance, the preventive maintenance is a basic maintenance practice that are considered as a cost-effective rehabilitation and enhance the pavements operational life.

Keywords: *Pavement maintenance, preventive maintenance, performance, traffic load.*

Introduction:

Pavement maintenance strategies have become a significant study field in the 21st Century. Maintenance practices are defined as all procedures that can be taken to resolve all possible deterioration forms. Such maintenance procedures must be implemented on the pavement surfaces when they remain considered efficient, and before the appearance of actual maintenance demands. Thus, the preventive maintenance treatment practices were recognised accompanied by the enhanced knowledge of the essential need of pavement management systems (Hein & Croteau, 2004). AASHTO Highway Committee defined preventive maintenance as a pre-designed plan that aims to treat existed roadway system in a preventing expected deterioration, cost-effective way that enhances the overall functional system performance (FHWA, 1999). These preventive maintenance treatment practices mainly aim to enhance the pavement performance by adding a planned maintainability and cost efficiency preventive strategies.

Pavement performance can be recognised through the performance curve that represents the relation between the possible loads on the road during the service time and the pavement situation. On the other hand, actual curves of performance could be generated depending on pavement deterioration historical reports. Figure (1) presents the typical performance curve of pavement, the figureindicates that the rates of pavement deterioration associated in an increasing manner until reaching to a high deterioration level at the end of the expected service life of the pavement (Butt et al., 1987).

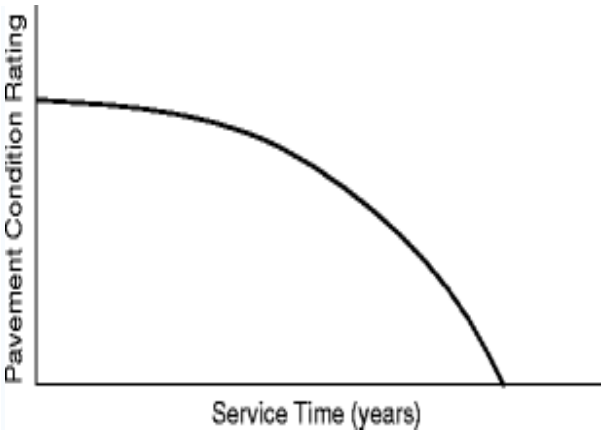

Figure (1): typical pavement performance curve

In this level, the pavement structure is expected to become unable to uphold the possible traffic loads. This stage clarifies the huge significance of pavement maintenance treatment practices to decrease the negative effects when reaching this stage especially quality and cost bad effects. Therefore, this paper attempts to investigate the impact of effective preventive maintenance treatment practices on pavement performance.

1.1 Study Aims and objectives:

This paper basically attempts to achieve the following objectives:

1. Examine the relationship between preventive maintenance treatment practices and the overall performance of the pavement.

2. To investigate factors that could influence pavement performance.

3. To asses road management strategies through defining efficient way and time to apply maintenance treatment practices.

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2. Pavement types:

Pavement can be defined as a solid covering floor that creates a suitable surface for traveling. There are several classifications of pavement types and the main types are (Flexible and rigid) pavements which will be discussed as follows;

2.1 Flexible pavement:

Flexible pavement is composed of various granular material layers that covered by a surface layer which consists of bituminous waterproof materials. This type of pavement is considered a flexible one due to the fact that its bend under high traffic load levels. The flexible pavement design basically aims to distribute the load to all flexing layers to avoid the excessive stressing of one layer which will cause the failure of the overall pavement design. The following figure illustrates the flexible pavement design and the distribution of loads over it:

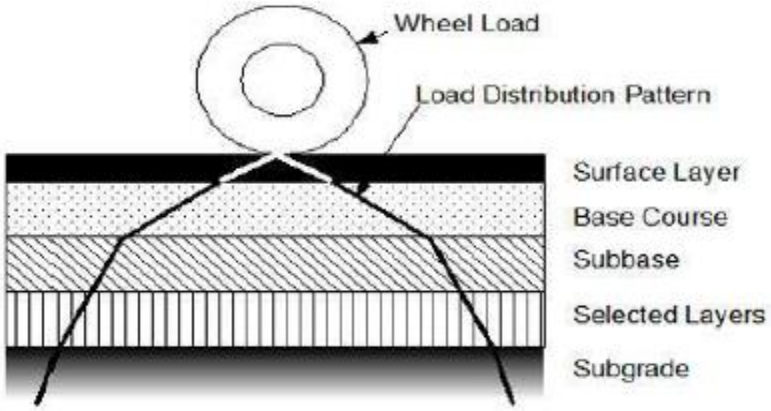

Figure (2): The flexible pavement design

The basic concept of flexible pavement design is to transport the loads to the pavement layers that have various strengths. The highest stress level is directly exposed to the top layer; therefore, this layer is considered as the least flexible and the strongest material layer. Whereas, the deeper pavement layer that exposed to the lowest stress level is the most flexible one (David, 2006).

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2.2 Rigid pavement:

This pavement is a stiffer pavement that basically consists of Portland cement concrete (PCC) course surface. The PCC material has a high modulus of elasticity which made this kind of pavement owns a sufficient flexural strength that enables it to transfer the exposed traffic load to a wider area.

In this pavement type, the slab action is the common pattern of load distribution as the rigid pavement reacts as an elastic surface that laid over a rigid layer that constructed by PCC materials (Mathew & Rao, 2007). Figure (3) illustrates the common load distribution shape over rigid pavement surface.

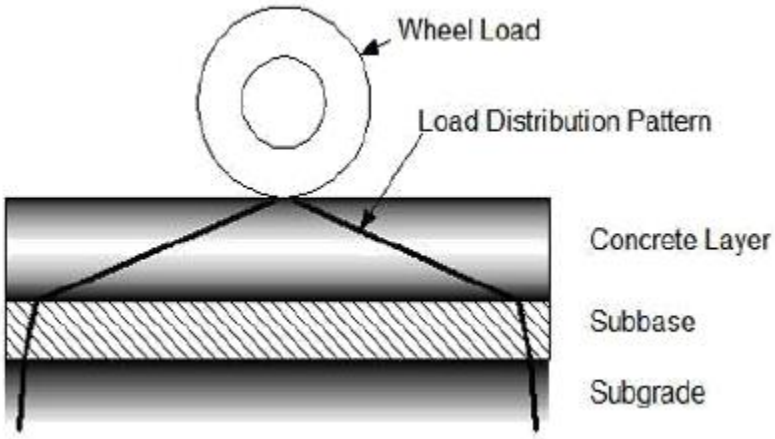

Figure (3): The Rigid pavement design and load distribution

3. Factors that affect pavement performance:

There are various factors that influence the overall pavement performance such as (Sitaramanjaneyulu et al., 1998; Norman, 2009):

1. The quality of construction:

The pavement performance is directly influenced by the quality of utilised construction materials, the proper moisture percentage and the proper compaction. All of these terms could be achieved when recruiting skilful construction employees, and when implementing a good quality control construction practices.

2. Traffic load

The volume, repetitions and duration of exposed traffic load are the basic factors that could influence the performance of pavements. The pavement deterioration that existed according to traffic loads is defined as the damage that could be caused per load pass of the standard axle (which is equal to 80 KN single axle load [E80]). Therefore, the ability to tolerate a repeated standard axle load (E 80's) is the basic standard of designing any pavement.

3. Moisture:

Adding an improper level of moisture in a pavement could considerably weaken the coherence of gravel materials, and weaken the overall pavement. There are various sources of pavement moisture, such as, the moisture that enters through pavement cracks and surface holes. In addition to moisture that comes through capillary action of pavement underlying water table. The main issues that could be generated according to the excessive moisture levels are the particles lubrication, easy displacement of pavement particles and loss of particle interlock, which could cause the failure of pavement performance.

4. Subgrade:

Subgrade surface can be defined as the underlined pavement surface that directly exposed to wheel loads. If this underlying surface of soils is too weak then the pavement will fail due to the excessive flexing behavior of the pavement under the traffic load. If this layer is not designed adequately, then the pavement failure will be noticed.

5. Maintenance:

The kind and the time of implementing maintenance practices are considered as the main influencer of the quality of the overall pavement performance. Additionally, the way of implementing the maintenance procedures is a crucial factor that has a great impact on the performance. All pavements will deteriorate when time passing according to the above-mentioned factors. Therefore, the maintenance practices are an essential step to enhance and solve the deterioration conditions. Adding the proper type of maintenance in the right time could lower the expected rehabilitation cost, and enhance the pavement efficient performance. Therefore; this paper will focus on one kind of maintenance practices which is the preventive maintenance and its influence on pavement performance.

4. Preventive maintenance:

The maintenance practices can be divided into various kinds such as; preventive, periodic and major maintenance approaches. Preventive (Routine) maintenance is considered as one of the essential pavement maintenance practices to keep roads surfaces in sufficient usable situation, and to avoid reaching to the major corrective maintenance conditions. The preventive maintenance includes crack sealing, patching, drainage recovering and edge repairing practices (Odoki & Kerali, 2002). One of the main maintenance practices that could avoid the overall pavement deterioration is the drainage repairing practices. Road appurtenances and plant control

activities are other essential preventive maintenance activities. In general, Patching and sealing are considered the critical issues that preventive maintenance seeks to avoid. The main aim of patching repairing practices is to evade roads surface deterioration through potholing repairing andsolving the structural cracks problem. On the other hand, Crack sealing maintenance practices basically deal with wide structural cracking and in treat transverse thermal road cracking. The main healing priority of this maintenance kind is to treat the transverse thermal cracking and this should accompany with the wide structural cracking to take this issue as a critical problem to be solved by the crack sealing preventive maintenance practices (Hein & Croteau, 2004). Preventive maintenance depends on implementing a cost-effective rehabilitation strategies without enhancing the structural pavements capacity (Peshkin & Hoerner, 2005). The following figure illustrates the main benefits of adding preventive maintenance strategies;

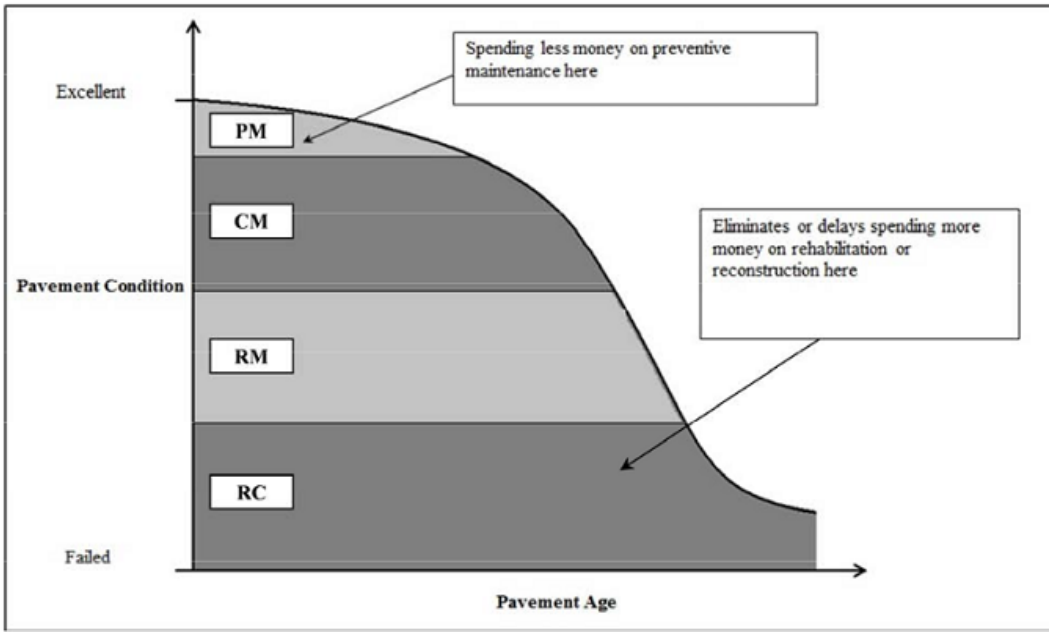

Figure (4): Benefits of preventive maintenance

The preventive maintenance often treats the surface of pavement in a manner that avoids the water to enter into the sub-layers of the pavement structure. The right time to implement such treatment practices is when the pavement is considerably at a good situation and in an acceptable condition to enhance the pavements operational life (Zaniewski & Mamlouk, 1999). Preventive maintenance practices are also considered as cost-effective rehabilitation strategies as it reduced the required cost of maintenance (Hicks et al., 1999).

5. Conclusions

Maintenance practices are defined as all procedures that can be taken to resolve all possible deterioration forms. Thus, the preventive maintenance treatment practices were recognised accompanied with the enhanced knowledge of the essential need of pavement management systems. These preventive maintenance treatment practices mainly aim to enhance the pavement performance by adding a planned maintainability and cost-efficiency preventive strategies. There are various factors that influence the overall pavement performance. The kind and the time of implementing maintenance practices are considered as the main influencer of the quality of the overall pavement performance. Preventive maintenance basically depends on implementing a cost effective rehabilitation strategies without enhancing the structural pavements capacity. This pavement treatment practices could enhance the overall operational pavement performance while adding a cost-effective maintenance practices when the pavement is considered at the acceptable working condition.

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