

Review Paper On Defects in Flexible Pavement and its Maintenance

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Abstract

This paper summarizes the ongoing researches about the defects in flexible pavement and the maintenance in flexible pavements. In the past, lots of researchers have already studied the defects and problems of maintaining the flexible pavements all over the world. Efforts have been made to refer some of the publications related to this topic. Various defects in flexible pavements have been identified since the existence of flexible pavement. Pavement structure can be destroyed in a single season due to water penetration. Defects in flexible pavements is a problem of multiple dimensions, phenomenal growth of vehicular traffic (in terms of no. of axle loading of commercial vehicles), the rapid expansion in the road network, non-availability of suitable technology, material, equipment, skilled labor and poor funds allocation have all added complexities to the problem flexible pavements. Maintenance is set of activities directed towards keeping a structure in a serviceable state during its design life. Maintenance of a road network involves a variety of operations, i.e., identification of deficiencies and planning, programming and scheduling for actual implementation in the field and monitoring. The essential objective should be to keep the road surface and appurtenances in good condition and to extend the life of the road assets to its design life. Broadly, the activities include identification of defects and the possible cause there off, determination of appropriate remedial measures; implement these in the field and monitoring of the results.

Keywords

Defects, Flexible Pavement, Maintenance, Road, Rutting, Paved Roads.

I. Introduction

A road network system is perhaps one of the most important necessities for the economic development of any country, particularly developing countries. Many of developing countries, therefore, invest huge amount on road construction, while many developing countries appreciate the necessity for huge investment in capital development of roads. Only a few give due importance to the road maintenance. It is found more glamorous to embark on new construction than to maintain what is already in existence. But unfortunately pavement structure can be destroyed in a single season due to water penetration. Maintenance activities may be required at intervals throughout the year, but their frequency varies with traffic, topography and climatic conditions, type of roads, grading and repairing pot holes and ruts for paved roads. They include repairing pot holes, surface patching, sealing of cracks and road surface marking. Transportation contributes to the economic, industrial, social and cultural development of any country. Transportation is vital for the economic development of any region since every commodity produced whether it is food, clothing, industrial products or medicine needs transport at production and distribution stages. The inadequate transportation facilities retard the process of socio-economic development of the country. The adequacy of transportation system of a country indicates its economic and social development. The most demanding fact is that this country needs to provide road links both for major proportions of villages and marked centers like significant important roads, important buildings, destinations of schools and hospitals, etc. India has got second largest road network in the world. . The road network has expanded from 4 lakh km in 1947 to 20 lakh km in 1993 and almost 55 lakh kms as on 31 March, 2015. India has less than 3.8 kms of road per 1000 people; including all its paved and unpaved roads. In terms of quality, all season, 4 or more lane highways; India has less than 0.07 kms of highway per 1000 people as of 2010. Construction of roads involves substantial investment and therefore proper maintenance of these assets is of paramount importance. The road user cost, comfort and safety

are influenced to a large extent by its state of maintenance. The quality of roads is a critical indicator of a nation's economic vitality because a poor road transport system can constrain the location of economic activity, hamper the integration of economic markets, limit the gains from specialization and eventually become a major barrier to growth and competitiveness. In India large road networks built at great expense, have been inadequately maintained and used more heavily than the design values. The main deficiencies affecting our highway system apart from inadequate capacity and insufficient pavement thickness include poor riding quality, weak and distressed bridges/culverts, congested sections, excessive axle loading, and lack of wayside amenities and enforcement. Among various modes, roads and road transport has come to occupy a dominant position in the transportation system. Factors that contributed in this direction are flexibility, door to door service, reliability and speed. India has second largest road network across the world at 4.7 million km. This road network transports more than 60 per cent of all goods in the country and 85 per cent of India's total passenger traffic. The Indian roads carry almost 90% of the country's passenger traffic and around 65% of its freight. Maintenance of roads is a problem of multiple dimensions, phenomenal growth of vehicular traffic (in terms of no. of axle loading of commercial vehicles), the rapid expansion in the road network, non-availability of suitable technology, material, equipment, skilled labour and poor funds allocation have all added complexities to the problem of the maintenance of roads. The maintenance of existing roads tends to get neglected at the cost of new construction and financial constraints.

India is a vast country having extreme variation in climatic conditions. North-Eastern region gets very heavy rainfall and annual rainfall as much as 600 cm per year has been recorded, whereas the deserts of Western India get very less rainfall. Even in a particular area the difference between maximum and minimum temperature of the year may be as high as 420°. North India experiences heavy snowfall during winter at altitudes above 2000 m. These climatic conditions have great influence on the type of

problems existing on the road as only 47% are surfaced roads, balance being earthen roads.

II. Types of Defects

Various defects in flexible pavements have been seen and those are listed below:

- (a) Cracks:
 - Alligator Cracking
 - Longitudinal Cracking
 - Block Cracking
 - Edge Cracking
 - Centre Cracking
- (b) Rutting and Shoving:
 - Rutting Classification
 - Shoving
- (c) Pot Holes and Patching:
 - Pot Holes
 - Patch Deterioration and Repairs
- (d) Bleeding, Releveling and Weathering:
 - Bleeding
 - Releveling and Weathering
- (e) Miscellaneous Type of Defects:
 - Polished Aggregates
 - Corrugations

III. Problems Faced During Road Maintenance

The various types of problems faced during maintenance of roads in general have been discussed in brief below:

- I. Problem of drainage system-Efficient drainage is a must for any highway system/road network, especially in heavy rainfall mountainous and low lying areas; all drainage structures must be well designed and adequately maintained.
- II. Geological problem-In India, we experience frequent landslides, flash folds etc. in hilly regions and shifting sand dunes in deserts of western region cause lot of problems to highway engineers. Similarly snow clearance and road maintenance in high altitude snow bound areas is a challenging task to field engineers, the extreme and adverse climatic conditions reduce the efficiency of man and machine.
- III. Shortage of equipment skilled labour, lack of modern technology and non-existence of updated guideline standards and norms for maintenance of roads.
- IV. Damage to subgrade due to seepage of water into the subgrade.
- V. Poor quality control during initial construction stage and inadequate thickness of pavement, excessive overloading adds to the maintenance enforcement problems.
- VI. Stability of subgrade and top layers is decreased under adverse moisture conditions, frost action and temperature variation.

IV. Classification of Maintenance Activities

Engineering maintenance as far as the road is concerned should be taken as comprising several small scale engineering activities that are carried out at varying intervals, depending upon climate, terrain, traffic and design standards of the roads. All the operations described here are aimed at keeping or restoring the road to a state of preservation and acceptable standards for its current and intended uses. These operations can be classified as routine, recurrent, periodic and urgent. The routine activities are likely to be required, irrespective of the engineering characteristics of

the road or the density of traffic it carries. Cost activities include grass cutting, cleaning of ditches, culverts and bridges and road sign maintenance.

Maintenance of highway is classified under the following categories:

- Routine Maintenance
- Periodic Maintenance
- Special Maintenance

1. Routine Maintenance

Activities involved in routine maintenance are irrespective of the engineering characteristic of road and density of traffic carried by it. These are required to be carried out throughout the year. The works to be attended under this category are as follows:

- Upkeep of carriageway.
- Road sign maintenance.
- Maintenance of berms/shoulder and subgrade.
- Repair to pot holes, cracks and other minor defects.
- Cleaning of drains and clearing of choked culverts.
- Rectification of corrugations formed.
- Minor repair of culverts/bridges.

2. Periodic Maintenance

It is nothing but periodic renewals of existing surface. In this type of maintenance a surfacing layer over the pavement at regular intervals of time so as to preserve the characteristics of the pavement and offset the wear and tear caused by traffic, weathering, etc. and thereby prolongs the life of pavement. The various types of periodic maintenance are as follows:-

- (a) For unpaved roads:
 - Graveling.
- (b) For paved roads:
 - Surface dressing
 - Thin premix carpet
 - Thin mix seal surfacing
 - Improving drains
 - Road surface marking

3. Special Repairs

The type, frequency and degree of maintenance of pavements can influence performance and time at which major rehabilitation such as overlay is required. Pavement rehabilitation is performed due to following two reasons:

1. To correct existing distress and improve riding quality.
2. To increase the structural capacity of pavement.

In order to increase the service life of an existing road, the works to be carried out are widening, overlays, removing old surfaces and constructing new pavements, improving drains, culverts, bridges, repairing walls and stabilization of soils.

Overlay is necessary when pavement section cross their maximum acceptable limits of deflection, rut depth, roughness and cracking and there is increase in traffic intensity. Overlay is generally laid when Characteristic Deflection (DC), Rut Depth Index (RDI), Crack Index (CI) and Roughness Index (RI) reach acceptable limits. Classification of Rut Depth Index and Crack Index is given in Table.

Table: Classification Of Rut Depth Index And Crack Index

Transverse Deformation under a 3 m long straight edge			Degree of Cracking Visible cracking		
Classification	Deformation (mm)	RDI	Classification	Crack Length per unit metre	CI
D1	< 10	1	C1	NIL	1
D2	10-15	2	C2	< 1	2
D3	15-20	3	C3	1-2	3
D4	20-25	4	C4	2-5	4
D5	>25	5	C5	5-7	5

V. Status of Ongoing Researches

HninEiEiKhaing and Dr. Tin TinHtwe (2014), in their study the major purpose was to improve the pavement of Maguway Yangon Highway in order to provide a satisfactory surface over which the vehicles could move safely. In this study failure patterns were classified between every five miles for the existing pavements by visual inspection. The stress and deflection of above mentioned highway was determined by using the method of soil mechanics of three layered system. The required overlay thickness was evaluated in accordance with Indian Road Congress Formula (IRC). From this study it was concluded that maximum overlay thickness was 6 inches and the minimum was 4.5 inches; whereas maximum granular overlay thickness was 12 inches and minimum was 9 inches.

Mr. EtikalaNagaraju (2015), in this study the major focus was on rehabilitation of pavement and its maintenance. As the road networks are subjected to severe deterioration leading to premature failure of the pavements. From this study it is concluded that significant savings could be obtained by choosing various rehabilitation strategies that include recycled materials in new layers.

Magdi M.E. Zumrawi (2015), the objective of this study was to visually inspect and evaluate flexible pavement failures for maintenance planning. It is very important to identify and then examine the causes of failed pavements and further to select proper treatment option. This study consists of two tasks in which first part covers the visual inspection of existing pavement failures whereas the second task was to investigate the actual causes of these failures. In this study, Obeid Khaitim Road was selected for investigation. The damaged pavement sections suffered from severe cracking and rutting failures. The damage to existing roads could be due to poor drainage conditions, inadequate design and improper pavement materials used.

Aggarwal et al. (2005), has given an overall picture of the problems of road networks in developing countries, which are rapid traffic growth, inadequate funding for maintenance and upkeep, lack of skilled man power, attitude towards maintenance etc.

Thube et al. (2005), critically reviewed the maintenance management strategy for low volume roads in India and stressed the need for development of pavement distress data base, deterioration models, optimal investment and maintenance strategy and highlighted the need for a suitable National level policy regarding paving of unpaved low volume roads in India.

Woods and Adcox (2004), pavement failure may be considered as structural, functional, or materials failure, or a combination of these factors. Structural failure is the loss of load carrying capability,

where the pavement is no longer able to absorb and transmit the wheel loading through the structure of the road without causing further deterioration. Functional failure is a broader term, which may indicate the loss of any function of the pavement such as skid resistance, structural capacity, and serviceability or passenger comfort. Materials failure occurs due to the disintegration or loss of material characteristics of any of the component materials.

Caltrans (2001), categorized the main types of pavement failures as either deformation failures or surface texture failures. Deformation failures include corrugations, depressions, potholes, rutting and shoving. These failures may be due to either traffic (load associated) or environmental (non-load associated) influences. It may also reflect serious underlying structural or material problems that may lead to cracking. Surface texture failures include bleeding, cracking, polishing, stripping and raveling. These failures indicate that while the road pavement may still be structurally sound, the surface no longer performs the function it is designed to do, which is normally to provide skid resistance, a smooth running surface and water tightness. Other miscellaneous types of pavement failures include edge defects, patching and roughness.

Ahmed (2008), potholes are an indication of structural surface failure and they result from growth of a break in the surfacing, often as a result of severe alligator cracking as shown in Plate 2. Once water enters pavement layers, the base and/or subgrade become wet and unstable, and the resultant degradation leads to rapid growth of pothole area and depth.

Sikdar et al. (1999), reported that if the potholes are numerous or frequent, it may indicate underlying problem such as inadequate pavement or aged surfacing requiring rehabilitation or replacement. Water entering pavement is often the cause, and could be caused by a cracked surface, high shoulders or pavement depressions ponding water on pavement, porous or open surface, or clogged side ditches.

SandeepChoudhary and Dr. P.K. Agarwal (2013), the major objective of this study was to develop an innovative strategy for maintenance of highway pavement. As the highway pavements are deteriorating at a faster rate due to lack of timely maintenance, leading to higher Vehicle Operating Cost (VOC) and also increasing the no. of accidents.

Sharad S.Adlinge and A.K. Gupta (2013), in this paper the pavement failure was defined in terms of decreasing serviceability caused by the development of cracks and ruts. The purpose of this study was to evaluate the possible causes of pavement distresses and to recommend remedies to minimize distress of a pavement. In this study various pavement preservation techniques and measures are discussed from the past experience which would be helpful in increasing the serviceable life of pavement.

VI. Conclusion

After going through number of researches I conclude that defects in flexible pavement is a problem since long time and there is a need of identification of problems and rectifying them. Thus it is concluded that a research needs to be done so as to see the various alternatives which can be adopted. The research should mainly have the objectives as:-

- (a) To identify type and classification of common defects in flexible pavements.
- (b) To identify the causes of these defects and suggest remedial measures.
- (c) To identify the deficiencies in existing pavement maintenance practices.

- (d) To rectify the identified defects for smooth movement of traffic flow.

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