Literature Review on Types of Flexible Pavement Failures
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Abstract— Pavement deterioration is a serious problem for road and traffic sector in almost every country. There are basically two types of pavements which are used for transportation of goods as well as passengers or people. One is flexible pavement and other is rigid pavement. The flexible pavements are known as bituminous roads. Due to continuous movement of vehicles on roads the different types of pavement failures like fatigue cracking, rutting and thermal cracking, pot holes are observed. The resurfacing of flexible pavements will enhance the life of pavements as well as it strengthens existing layers of pavements. Here in this article authors had discussed basic causes of flexible pavement failures. The flexible pavements have very long design life. Due to rainwater, continuous movement of vehicles, temperature variation, seasonal effects this types of pavements requires maintenance. The surface condition of flexible pavements affects the day and night visibility. So it is required to prevent the condition of flexible pavement during all seasons. Here we explained the basic types of flexible pavement failures and remedial measures.

Key words: Bituminous Pavements, Cracking, Pot Holes

I. INTRODUCTION

A pavement is a raised paved or asphalted path for the movement of pedestrians and vehicles at the side of a road. It is made as a hard and strong surface for travel; it is side walk, road, pedestrian walk way etc. The roads which are constructed for the transfer of vehicles are classified in two categories. One is flexible pavements ad other is rigid pavements. Flexible pavements are known as bituminous roads and the rigid pavements are known as cement concrete roads. The flexible pavements are constructed of several layers of natural granular materials covered with one or more water proof bituminous surface layers. As the name suggests the flexible pavement will flex (bend) under the wheel load of vehicle. The objective of design of flexible pavement is to avoid excessive bending of any layer, because it will results in overstressing of a layer which ultimately cause the failure of pavement. In the case of flexible pavements load distributes from one layer to another layer because the strength of each layer is different. The flexible pavement consists of base course, sub base course, sub grade and top bituminous layer. The following figure indicates cross section of flexible pavement.

II. TYPES OF BITUMINOUS PAVEMENT FAILURES

Different types of flexible pavement failures as listed below:
- Alligator cracking or Map Cracking (Fatigue behavior)
- Consolidation of Pavement layers (Rutting)
- Shear failure cracking
- Longitudinal cracking
- Frost heaving effect
- Lack of binding to the lower course
- Reflection cracking
- Formation of waves and corrugation
- Bleeding and pumping effect

A. Alligator or Map cracking effect

This is common types of failure of flexible pavements. It is also known as fatigue failure. Following are the primary causes of this type of failure:
- Relative movement of pavement layer material
- Repeated applications of heavy wheel loads
- Swelling or shrinkage of sub grade or other layers due to moisture variations
B. Consolidation of Pavement failures (rutting)
Formation of ruts falls in this type of failure. A rut is a depression or groove worn into a road by the travel of wheels. This type of failure is caused due to following reasons. Repeated application of load along the same wheel path resulting longitudinal ruts and wearing of the surface course along the wheel path resulting shallow ruts are basic reasons of this type of failure.

C. Shear Failure Cracking
Shear failure causes upheaval of pavement material by forming a fracture or cracking. The primary causes of shear failure cracking is due to excessive wheel loading and low shearing resistance of pavement mixture.

D. Longitudinal Cracking
This types of cracking extends to the full thickness of pavement. It is due to differential volume change in the sub grade soil, settlement of fill material and sliding of side slopes.

E. Lack of binding with lower level (potholes and slippage)
When there is a lack of binding in surface course and underlying course, some portion of surface course loses their material which causes pot holes and patches. Slippage cracking is one form of this type of failure. Lack of prime coat and tack coat in between two layers is reason behind this type of failure.

F. Formation of waves and corrugations
Transverse undulations appear at regular intervals due to unstable surface course caused by regular stop and go traffic.

G. Bleeding
Excess bituminous binder occurring on the pavement surface causes bleeding effect. Bleeding causes shiny, glass like reflective surface that may be tacky to the touch. It is usually found in the wheel path.

H. Pumping
Seeping or ejection of water and fines from beneath the pavement through cracks is called pumping effect.

III. REMEDIES TO PREVENT FLEXIBLE PAVEMENT FAILURES
The overview of techniques used for preventive and corrective maintenance of flexible pavements are as follows:

1) Bituminous surface treatments known as seal coat which is thin protecting wearing surface that is applied to a pavement or base course. It provides a waterproof layer to underlying surface, increased skid resistance, a filler for existing cracks or raveled surfaces and anti-glare surface during wet weather and an increased reflective surface for night driving.

2) Crack seals products are used to fill individual pavement cracks to prevent entry of water or other materials like sand, dirt, rocks and weeds. Crack sealant is typically used on early stage longitudinal cracks, transverse cracks, reflection cracks and block cracks.

3) HMA (Hot Mix Asphalt) Patching: Patching is common method of treating an area of localized distress. Patches can be either full depth or where they extend from the pavement surface to the sub grade or partial where they do not extend through the full depth of existing pavement. Full depths of patches are necessary when the entire depth of pavement is distressed. Often times, the underlying base, sub base or sub grade material is the distress root cause and also need repair. Partial depth patches are used for pavement distresses like raveling, rutting, and delimitation and cracking where the depth of cracks does not extend through the entire pavement.
depth. Patching materials can be about any HMA or cold mix asphalt material as well as certain types of slurries. Typically some form of HMA is used for pavement patches, while cold mix is often used for temporary emergency repairs.

REFERENCES