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Study of pavement failure, their possible cause and Factors affecting the performance of a pavement.

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Abstract : Pavement is the durable surface material laid down on an area intended to sustain vehicular or foot traffic, such as a road or walkway. In the past, gravel road surfaces, cobblestone and granite sets were extensively used, but these surfaces have mostly been replaced by asphalt or concrete laid on a compacted base course. Road surfaces are frequently marked to guide traffic. Existing Pavement after course of time and due to movement of traffic over it, the life of pavement cease and required reconstruction of road completely and new layers are to be provided. Reconstruction works is costly and time consuming. Traffic plying on existing road is to be diverted or numbers of diversion road is to be constructed during reconstruction activity. To avoid this situation, overlay is best solution which will increase life of pavement, cost and time saving. Requirement of Overlay thickness is essentially depends upon characteristic of existing pavement layers. Index used to ascertain characteristics of existing pavement layers is deflection under defined loading (through wheel load) and rebound in original position after release of loads which is terms as characteristic deflection. In India.

The satisfactory performance of the pavement will result in higher savings in terms of vehicle operating costs and travel time, which has a bearing on the overall economic feasibility of the project. This paper discusses about the design methods that are traditionally being followed and examines the "Study on strengthening and rehabilitaiton of flexible pavement with overlay using fwd test vs. Reconstruciton".

Key Words : Overlay Design, Flexible Pavement, Existing Pavement Layer Analysis

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TYPES OF PAVEMENT FAILURES

There are various type of pavements failure depending upon construction quality and characteristics of vehicle plying before reaching its design traffic. Pavement investigation is to be carried out time to time before ultimate failure of pavement. In many cases well planned overlay with through investigation of pavement will extend life of pavement and reduce cost of project. Some of pavement failures are described as :

- Alligator Cracking
- Block Cracking
- Longitudinal (Linear) Cracking
- Raveling
- Transverse Cracking
- Potholes
- Rutting
- Lack of binding to the lower course
- Reflection cracking
- Formation of waves and corrugation
- Bleeding
- Pumping

[1]. Raveling

The progressive disintegration of pavement layer from the surface download as a result of the dislodgement of aggregate particles:

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Raveling in Pavement

The failure can be due to loose debris on the pavement, roughness, water collecting in the raveled locations resulting in vehicle hydro planning, loss of skid resistance.

Possible cause: Loss of bond between aggregate particles and the asphalt binder as a result of

A dust coating on the aggregate particle that forces the asphalt binder to bond with the dust rather than the aggregate

Aggregate segregation if the fine particles are missing from the aggregate matrix then the asphalt binder is only able to bind the remaining coarse particles at their relatively few contact points.
Inadequate compaction during construction. High density is required to develop sufficient cohesion within the Hot Mix Asphalt
Repairs: A raveled pavement should be investigated to determine the root cause of failure. Repair strategies generally fall into one of two categories:

- Small localized areas of raveling. Remove the revealed pavement and patch
- Large raveled areas indicative of general Hot Mix Asphalt failure. Remove the damaged pavement and overlay.

[2]. Alligator Cracking

Cracks in pavement surface due to structural failure which starts as longitudinal cracks in wheel path and spread as alligator cracking.

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Alligator Cracking in Pavement

The failure can be due to weakness in the surface, base or subgrade.

Possible cause:

- Thin surface and base course layer
- Inadequate or poor subgrade
- Poor drainage or combination of three

Repairs: As a structural failure is taking in place the only possible solutions to alligator cracking is to perform a full depth patch.

[3]. Block Cracking

Block cracking look like interconnected rectangles (roughly). Block cracking is not load-associated, but generally caused by shrinkage of the asphalt pavement. due to an inability of asphalt binder to expand and contract with temperature cycles.

Possible cause: Shrinkage of asphalt pavement due to an inability of asphalt binder to expand and contract with temperature cycles.

Mix was mixed and placed too dry, Fine aggregate mix with low penetration asphalt & absorptive aggregates, poor choice of asphalt binder in the mix design, or aging dried out asphalt.

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Block Cracking in Pavement

Repairs: Less severe cracks measuring 10-15 mm or less can be sealed to prevent moisture from entering into the subgrade. More severe cracks should be fixed by removing the cracked pavement layer and replacing it with an overlay.

[4]. Longitudinal (Linear) Cracking

Longitudinal cracking are cracks that are parallel to the pavement centerline or laydown direction.

Possible cause: These can be result of fatigue, reflective cracking, and or poor construction joints. Joints are generally least dense areas of a pavement.

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Longitudinal (Linear) Cracking in Pavement

Repairs: Less severe cracks measuring 10-15 mm or less can be sealed to prevent moisture from entering into the subgrade. More severe cracks should be fixed by removing the cracked pavement layer and replacing it with an overlay.

[5]. Transverse Cracking

Transverse cracks are single cracks perpendicular to the pavement's centerline or laydown direction.

Possible cause: Transverse cracks can be caused by reflective cracks from an underlying layer, daily temperature cycles and poor construction due to improper operation of the paver.

Transverse Cracking in Pavement

Repairs: Less severe cracks measuring 10-15 mm or less can be sealed to prevent moisture from entering into the subgrade. More severe cracks should be fixed by removing the cracked pavement layer and replacing it with an overlay.

[6]. Joint Reflection Cracking

These are cracks in a flexible pavement overlay of a rigid pavement (i.e. asphalt over concrete pavement). These types of cracks occur directly over the underlying rigid pavement joints. Joint reflection cracking does not include reflection cracks that occur away from an underlying joint or from any other type of base

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Possible cause: Due to improper joint treatment during overlay

Joint Reflection Cracking in Pavement

Repairs: Less severe cracks measuring 10-15 mm or less can be sealed to prevent moisture from entering into the subgrade. More severe cracks should be fixed by removing the cracked pavement layer and replacing it with an overlay.

[7]. Potholes

Pothole is very common pavement failure in flexible pavement. Small, bowl-shaped depressions in the pavement surface that penetrate all the way through the asphalt layer down to the base course. They generally have sharp edges and vertical sides near top of the hole.

Possible cause: Potholes are the result of moisture infiltration and usually the end result of untreated alligator cracking. As alligator cracking becomes severe, the interconnected cracks create small chunks of pavement, which can be dislodged as vehicles drive over them.

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Potholes

Repairs: Full depths patch replacement.

[8]. Rutting

Ruts in asphalt pavements are channelized depressions in the wheel-tracks.

Possible cause: Rutting results from consolidation or lateral movement of any of the pavement layers or the subgrade under traffic. Rutting is caused due to insufficient pavement thickness, lack of compaction of the asphalt, stone or soil, weak asphalt mixes or moisture infiltration.

Rutting

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Repairs: If rutting is minor or if it has stabilized, the depressions can be filled and overlaid. If the deformations are severe, the rutted area should be removed and replaced with suitable material.

Factors Influencing The Performance Of A Pavement

Traffic: Traffic is the most important factor influencing pavement performance. The performance of pavements is mostly influenced by the loading magnitude, configuration and the number of load repetitions by heavy vehicles. The damage caused per pass to a pavement by an axle is defined relative to the damage per pass of a standard axle load, which is defined as a 80 kN single axle load (E80). Thus a pavement is designed to withstand a certain number of standard axle load repetitions (E80's) that will result in a certain terminal condition of deterioration.

Moisture (water): Moisture can significantly weaken the support strength of natural gravel materials, especially the subgrade. Moisture can enter the pavement structure through cracks and holes in the surface, laterally through the subgrade, and from the underlying water table through capillary action. The result of moisture ingress is the lubrication of particles, loss of particle interlock and subsequent particle displacement resulting in pavement failure.

Subgrade : The subgrade is the underlying soil that supports the applied wheel loads. If the subgrade is too weak to support the wheel loads, the pavement will flex excessively which ultimately causes the pavement to fail. If natural variations in the composition of the subgrade are not adequately addressed by the pavement design, significant differences in pavement performance will be experienced.

Construction quality: Failure to obtain proper compaction, improper moisture conditions during construction, quality of materials, and accurate layer thickness (after compaction) all directly affect the performance of a pavement. These conditions stress the need for skilled staff, and the importance of good inspection and quality control procedures during construction.

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Maintenance : Pavement performance depends on what, when, and how maintenance is performed. No matter how well the pavement is built, it will deteriorate over time based upon the mentioned factors. The timing of maintenance is very important, if a pavement is permitted to deteriorate to a very poor condition, as illustrated by point B in Error! Reference source not found., then the added life compared with point A, is typically about 2 to 3 years. This added life would present about 10 percent of the total life.

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