Good report about general causes of pavement failures

Experience, Failure

Abstract

Flexible pavement distresses are caused by poor design, wear and tear, and traffic loading beyond design capacity. The amount of loading that a pavement can bear without failure is determined by the strength of the subgrade and the surface layer. Pavement failures are of eight major types; potholes, bleeding, alligator cracking, rutting, shoving, depression, block cracking, and longitudinal cracking. Each pavement distress has causal gents and repair methods defined by local and international codes. This report shall focus on bleeding, potholes, and alligator failure.

Introduction

Potholes, bleeding, and alligator cracking which are the subject of this case study are some of the most serious pavement defects. Potholes and alligator failure shorten the lifespan of a pavement while bleeding affects safety on roads by causing skidding due to reduced friction between the pavement and the car tires. This case study focuses on these three distresses, their effects on pavements and how they are cured. A local two lane load was studied to enhance a deeper understanding of the actual damage caused by these distresses.

Pavement defects due to defects can be costly in terms repair costs and road accidents. If left unattended for too long, the defects deteriorate and may warrant the construction of a new pavement altogether. Most defects cause the breakage and cracks in the surface and the subgrade layers. These openings let moisture into the pavement layers which causes further damage by loosening the subgrade reducing its loading capacity. During

winter, continuous thawing cycles cause severe damage to the subgade which worsen the already existing distress.

Potholes

Potholes are caused by the collective effects of all the pavement distresses present on a road. Cracks due to the various defects cross up and isolate chunks of asphalt from the rest of the pavement. The isolated regions are weaker because they have lost all the load transfer capabilities leading to concentration of loads on each lone region. The weakened parts are easily knocked out by passing vehicles leaving voids on the pavement. Potholes are gaping holes in the surface layer and have sharp edges (Oregonstate. edu, 2014).

Figure 1: Potholes on a road

Alligator failure

Alligator cracking or failure is caused by subjecting the subgrade layer to a load that is beyond its rated capacity. Overloading the subgrade is manifested by cracks on the surface layer. The surface layer gives way and cracks once the subgrade shifts downwards due to loading. A poorly designed subgrade or the effects of moisture due to poor drainage may lead to alligator cracking. Stripping caused by chipping of the surface aggregates due to low adhesion with asphalt also causes alligator failure. Chipping reduces the overall pavement depth below the design parameters which lowers its capacity to carry initial design loads. The resulting cracks are aligned longitudinally and intersect at angles which mimics an alligator’s skin

patter (Wolf's Asphalt Paving Blog, 2014).

Figure 2: Alligator failure on a road section

Bleeding

Bleeding is caused primarily by excess asphalt in the HMA mix. The excess aspahalt on the surface heats in hot weather, melts, and forms a shiny and sticky film on the surface. Poor HMA mix preparation with little or no air spaces can cause bleeding where excess asphalt seeps onto the surface. The asphalt film is dangerous because it causes skidding in wet weather which may cause accidents (Oregonstate. edu, 2014).

Figure 3: Bleeding along a road section

Depression

Depression occurs when parts of a pavement subsides forming shallow troughs which fill up with water during dry rainy seasons. Depression is caused by poor compaction of the subgrade during construction and it later gets compacted by traffic loading.

Figure 4: Depressed part of a rod

Block Cracking

Block racking is characterized by rectangular fragmentation of a pavement. Block cracking is caused by contraction and expansion cycles in the HMA coupled with the rigidity of the asphalt binder. Inability to expand and contract in a pavement is caused by poor mixing of the HMA and aging (Oregonstate. edu, 2014).

Figure 5: Block cracking on a pavement

Longitudinal Cracking

Longitudinal cracks are parallel to the centre line in a pavement and are formed due to HMA fatigue, weak joints in the pavement layers, reflective cracks in the subgrade, and top down cracking.

Figure 6: Longitudinal cracking along the middle line

Shoving

Shoving is caused by action of traffic on a pavement. The action of starting and stopping of vehicles leads to formation of ripples on a pavement due to frictional drag. Waves and ripples are due to poor design of the HMA layer lading to low stiffness and reduced capacity to handle drag loading. Shoving is also caused by deterioration of the subgrade due to the action of moisture.

Figure 7: Shoving on a start stop section of a road

Rutting

Rutting is caused by shear displacement of the subgrade due to traffic loading and is characterized by sunken tracks are the wheel paths of heavy commercial vehicles. Rutting is caused by poor HMA mix design and poor and poor compaction. Lack of proper compaction makes the pavement layer susceptible to gradual traffic load compaction.

Figure 8: Rutting along the wheel tracks on a road

Failures observed in 300m road section and their causes

Bleeding

Bleeding as seen on the road section is on only on one side of the pavement.

This indicates that the cause of the bleeding is present on only one section of the pavement. The most likely cause of bleeding on this section could be the quality of finishing done on the affected side. Use of a non uniform HMA mix on either side may have caused the bleeding. Too much compaction may also have been applied on the affected side leading to the filling of the voids necessary for asphalt expansion. The bleeding can be solved by application of sandwich seals or chip seals given moderate severity of the problem.

Longitudinal Cracking

Longitudinal cracking on the pavement runs along the pavement length. The cracking was likely caused by poor longitudinal joints on the pavement during construction. As a result, the pavement sections did not merge into a single uniform structure and easily got disjointed under traffic loads. The cracking is not severe enough to warrant major construction works involving pavement replacement. Since the cracks are less than half an inch wide, crack sealant or crack raveling can be used to seal the cracks to prevent moisture entry which would worsen the failure.

Block Cracking

Block cracking on the observed pavement is characterized by cracks traversing the pavement width and longitudinal cracks on the pavement length which intersect to form the blocks. Cracking could have been caused by uneven expansion and contraction between the subgrade and the surface layer. Stretching of the rigid asphalt due to subgrade expansion could have caused it’s the surface layer to crack. The cracking is not severe and can be repaired through application of crack sealant or by raveling.

Formulation of Maintenance plan for the road distresses

Road maintenance is important in the preservation of good road conditions and saving on reconstruction costs. Road maintenance helps in keeping the road in its construction conditions, ensure user safety, and saves on transportation time and costs on the road. On the section of the road under study, failure is caused by lack of proper drainage and poor road design. The maintenance plan will mitigate the effects of these design defects.

Drainage system maintenance

Drainage maintenance will involve clearing of drainage ways to eliminate water traps which are likely to cause stalling of rain water. Drainage clearance involves removing all obstructions and debris. Poor drainage causes water logging which destabilizes the subgrade leading to various kinds of distresses.

Maintenance of the Road Surface

Maintenance of the road surface is essential as it ensures smooth run off of water from the surface by maintaining an ample slope or crown so that the water can flow through gravity. Surface checks involve examination of surface and subgrade deterioration. Pavement deterioration occurs during the wet season when the subgroup is subjected to a lot of moisture. Snow removal equipment also scraps part of the crown if the blade is not adjusted properly (FAO Corporate Document Repository, 2014). Ballast will be replaced every month following snow removal activities on the road. Regular checks will be done on the road surface to identify areas affected by major distresses. Major road maintenance activities will be scheduled every

six month. The patching and filling of potholes will be done every six months. Preliminary studies to identify worst hit road sections will be conducted before hand.

Procedure of road distresses examination

- Mark out the road section to examined.

- Place hazard signs on each side to warn oncoming traffic.

- Workers should b wearing reflectors and all the work vehicles should be equipped with chevron reflectors.

- Observations taken and classified in a scale of 1 to 16 where 1 is the highest priority and 16 requires the lowest priority.

Comparison between local and international pavement maintenance codes

Local and international pavement maintenance codes

Bleeding Repair

According to local codes, bleeding pavements are treated by applying a thin overlay, chip seals, or sandwich seals. These methods are similar to international codes which prescribe the use of rough sand to blot out the asphalt film. The difference between the two standards is that under severe bleeding conditions, international codes offer the option of removal of the excess asphalt by the use of a heater planer or a motor grader (Oregonstate. edu, 2014).

Longitudinal Repair

Treatment of Longitudinal cracking in both local and international codes is similar. Cracks are repaired by the use of a sealant in both cases. The only

difference is that international codes have the option of raveling to seal cracks below a half inch in width.

Block Cracking

Repair for block cracking is cured by use of sealant in both local and international codes. The two codes also offer the option of removal of damaged pavement parts in severe cases.

Conclusion

This project has taught me about the different pavement distresses, their causes, and the different methods of repair. I have gained a deeper understanding of each pavement defect, occurrence and the probable location of occurrence in a pavement. As an engineer, this knowledge will be instrumental in helping me diagnose pavement defects and choose an appropriate remedy in order to prevent further damages on the pavement. It will also help me in generating quality pavement designs suited for each type of loading and weather so that they do not deteriorate before their intended lifespan. As an engineer, I now posses the efficacy to direct and manage pavement design and maintenance works.

References

Wolf's Asphalt Paving Blog. (2014). What to Do When You See Alligator Cracking in Asphalt. Wolf Paving. Retrieved from http://www. wolfpaving. com/blog/what-to-do-when-you-see-alligator-cracking-in-asphalt

FAO Corporate Document Repository. (2014). Road Maintenance. Forestry Department. Retrieved from http://www. fao. org/docrep/006/t0099e/T0099e07. htm

Oregonstate. edu. (2014). 7 Flexible Pavement Distress. Oregon State University. Retrieved from http://classes. engr. oregonstate. edu/cce/spring2014/ce492/Modules/09_pavement_evaluation/09-7_body. htm#bleeding

Appendix

Observed Pavement Distresses

Figure 9: Bleeding

Figure 10: Block Cracking

Figure 11: Longitudinal Failure