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Study on Distress Patterns, Causes and Maintenance of Flexible Pavement for Selected Portions

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ABSTRACT

This paper presents the study on flexible pavement distresses and repair techniques in two selected road portions. It is very important to know the flexible pavement distresses and its patterns. Pavement deterioration is serious problem for road and traffic highway sector in Myanmar. Tada U-Airport road (6/0 to 8/0 mile) and Paleik-Tada U road (0/0 to 7/0 mile) portions are chosen in this study. The failure patterns are classified depending upon the visual investigation along the study areas and identify the failure patterns of the two selected road portions. Map cracking, depression, corrugation, rutting, longitudinal cracking, pothole, edge failure, crocodile cracking, delamination, raveling and bleeding are found in the selected road portions. Along the selected portions, the pavements are damaged by the effects of weather, organic growth, traffic wear and damages as well as deterioration due to aging, excessive traffic loading of heavy trucks, insufficient pavement thickness, material failure, design faults and construction faults. The required overlay thickness is calculated by using India Road Congress (IRC) formula. After calculated, Tada U-Airport road requires overlay thickness of 6 inches and Paleik-Tada U road requires overlay thickness of 5 inches.

KEYWORDS: *pavement, distresses, visual inspection, IRC, Investigation*

I. INTRODUCTION

Nowadays, a good system of transportation has become a measure of a country's economic and social development. In Myanmar, many save and convenient highway roads are needed to construct. There are different types of failures in flexible pavements. Pavement deteriorations or distresses can be classified into two basic categories for all pavement types – structural distress and environmental distress. The condition of a road will deteriorate due to the effect of weather, soil, aging, material failure, design fault, construction fault and traffic wear. After knowing the causes of failures and its patterns, maintenance activities can be effectively carried out. It includes both physical maintenance activities such as patching mowing, filling joints, seal coating, overlay, etc, and traffic service activities such as pavement markings, traffic signs, etc. If the maintenance activities of road are poor, it is not only detrimental to the traffic using it but also the road itself. Therefore, this study deals with the causes of failures and maintenance procedures for roads. In flexible pavement, the load carry capacity from distribution characteristic of the layered system and load is transferred by grain to grain contact. So, each layer of flexible pavement has adequate strength and which is very important.

II. Types of Distresses

One of the major challenges facing pavement engineers is how to select the optimal repair strategy for a flexible pavement that is aging and exhibiting distresses. This selection process can be relatively straightforward if the cause of the pavement distress is known. Unfortunately, finding the cause of the distress is often complex. The different types of distress in flexible pavement are tabulated in Table1.

Table1. Types of Distresses in Flexible Pavement and Causes

Types of Distresses	Causes of Failures
Pothole	➢ Lack of bond between the surfacing ➢ Moisture entry to base course through the cracked pavement surface ➢ Loss of surface course due to traffic load ➢ Repeated application of heavy loads
Map Cracking	➢ Water entry to base course through cracked portion ➢ Load associated disintegration of base ➢ Insufficient pavement thickness ➢ Seepage of water

Crocodile Cracking	➢ Inadequate pavement thickness ➢ Brittle wearing course ➢ Lack of pavement thickness during construction
Rutting	➢ Inadequate stability of base surfacing ➢ Inadequate compaction during construction ➢ Repeated application of heavy loads
Raveling	➢ Inadequate compaction during construction ➢ Loss of bond between aggregate and bitumen ➢ Insufficient drainage system and weather condition
Longitudinal Cracking	➢ Due to excessive load and repeated load ➢ Poor construction design ➢ Poor drainage and seepage of water ➢ Settlement of shoulder
Depression	➢ Inadequate pavement thickness ➢ Poor stability of pavement materials ➢ Poor quality subgrade and poor drainage ➢ Subgrade settlement resulting from inadequate compaction
Corrugation	➢ Lack of stability in bituminous mix ➢ Traffic action such as starting and stopping ➢ Moisture content and low quality materials used in mix
Edge Failure	➢ Poor shoulder materials to resist erosion and Poor drainage ➢ Inadequate pavement width and lateral displacement of embankment due to traffic load
Bleeding	➢ Lack of proper rolling ➢ Excess asphalt in surface layer ➢ Due to hot weather condition
Delamination	➢ Inadequate tack coat and Seepage of water ➢ Poor compaction during construction

III. Case Study

This study was concentrated on Tada UAirport road portion (6/0 to 8/0 mile) and PaleikTada U road portion (0/0 to 7/0 mile) in Mandalay Division, Myanmar. The selected portions are shown in Figure1 and 2.

Figure1. Location Map of Selected Road Portion in Tada UAirport Road

Figure2. Location Map of Selected Road Portion in PaleikTada U Road

A. Distresses Patterns in Tada UAirport Road

In this study, eleven types of distresses are found. They are pothole, crocodile cracking, map cracking, longitudinal cracking, rutting, raveling, depressions, corrugation, edge failure, bleeding and delamination. Some of the localized pavement failures are shown in the following figures.

Figure3. Localized Raveling in Tada UAirport Road

Figure4. Localized Map Cracking in Tada UAirport Road

Figure5. Localized Crocodile Cracking in Tada UAirport Road

Figure6. Localized Pothole in Tada UAirport Road

Figure7. Localized Depression in Tada UAirport Road

Figure8. Localized Delamination in Tada UAirport Road

Figure9. Localized Rutting in Tada UAirport Road

Table2. Number of Distresses in Tada UAirport Road

Failure Patterns	Number of Failures	Percentage (%)	Percentage (%)
	Mile (6/0-7/0)	Mile (7/0-8/0)	
Pothole	6	3	10.59 %
Map Cracking	5	3	9.41 %
Crocodile Cracking	3	4	8.23 %
Depressions	5	4	10.59 %
Rutting	7	5	14.12 %
Raveling	4	3	8.23 %
Corrugation	4	-	4.72 %
Edge Failure	4	5	10.59 %
Longitudinal Cracking	3	2	5.88 %
Bleeding	5	3	9.41 %
Delamination	3	4	8.23 %
Total	49	36	100 %

In this study area, there are 85 distresses found in Tada UAirport portion. In this study, 9 potholes, 8 map cracking, 7 crocodile cracking, 9 depressions, 12 rutting, 7 raveling, 4 corrugation, 9 edge failures, 5 longitudinal cracking, 8 bleeding and 7 delamination are founded during the field survey. The number of distresses and distress percentages of pavement at proposed road are described in Table2 and Figure10.

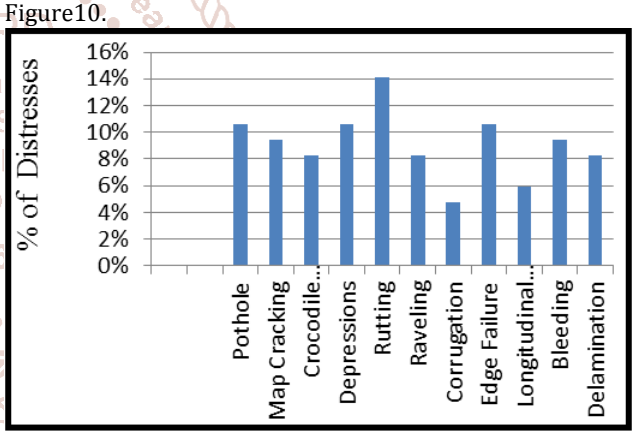

Figure10. Distress Percentages of Tada UAirport Road

B. Distresses Patterns in PaleikTada U Road

In this study, eleven types of distresses are found. They are pothole, crocodile cracking, map cracking, longitudinal cracking, rutting, raveling, depressions, corrugation, edge failure, bleeding and delamination. Some of the localized pavement failures are shown in the following figures.

Figure11. Localized Raveling in PaleikTada U Road

Figure12. Localized Map Cracking in PaleikTada U Road

Figure15. Localized Pothole in PaleikTada U Road

Figure13. Localized Crocodile Cracking in PaleikTada U Road

Figure16. Localized Delamination in PaleikTada U Road

Figure14. Localized Depression in PaleikTada U Road

Figure17. Localized Edge Failure in PaleikTada U Road

In this study area, there are 545 distress found in PaleikTada U road portion. This portion presents 7 miles from 0/0 to 7/0 miles. There are 91 potholes, 39 map cracking, 77 crocodile cracking, 60 depressions, 61 rutting, 82 raveling, 40 corrugation, 41 failures, 34 longitudinal cracking, 10 bleeding and 10 delamination. The number of distresses and distress percentages of pavement at proposed road are stated in Table3 and Figure18.

Table3. Number of Distresses in PaleikTada U Road

Failure Patterns	Number of Failures				Percentage(%)
	Mile (0/01/0)	Mile (1/03/0)	Mile (3/05/0)	Mile (5/07/0)	
Potholes	12	30	21	28	16.70 %
Map Cracking	8	10	10	11	7.16 %
Crocodile Cracking	11	28	18	20	14.13 %
Depression	8	17	14	21	11.10 %
Rutting	4	24	21	12	11.19 %
Raveling	8	30	22	22	15.05 %
Corrugating	8	12	13	7	7.34 %
Edge Failure	7	12	9	13	7.52 %
Longitudinal Cracking	7	5	8	14	6.24 %
Bleeding	4		2	4	1.83 %
Delamination		4	6		1.83 %
Total	77	172	144	152	100 %

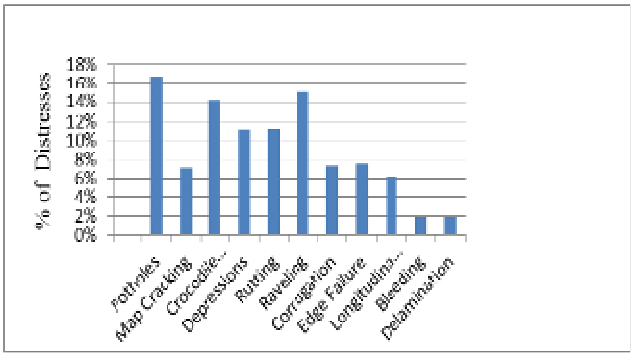

Figure18. Distress Percentages of PaleikTada U Road

IV. Repair Method

After knowing the distress patterns and causes of pavement distresses, the suiTablemaintenance activities are carried out according to pavement distresses.

A. Repair Method of Tada U-Airport Road

The failure patterns and suiTablerepair methods of Tada U-Airport Road are shown in Table4.

Table4. Repair Method of Tada U-Airport Road Portion

Failure Patterns	Repair Methods
Pothole	➢ Base patching ➢ Filling potholes with premix materials
Map Cracking	➢ Removal of the cracked area then digging out and replacing the area with premix ➢ Overlay, Thin HMAs Overlay
Crocodile Cracking	➢ Treatment based on the severity and intensity of cracks starting using overlay, seal coat, surface patching or reconstruction
Rutting	➢ Filling the ruts using either a dense graded bituminous mix or open graded premix ➢ Seal Coat and Local Sealing
Raveling	➢ Application of sanding ➢ Seal Coat and Local Sealing
Longitudinal Cracking	➢ Cut and Patch ➢ Seal Coat, Local Sealing and overlay

Table4. Continued

Depression	➢ Filling Depression, Base Patching ➢ Overlay and Thin HMAs Overlay
Corrugation	➢ Seal Coat, Local Sealing ➢ Reconstruction
Edge Failure	➢ Shoulder Strengthening, rebuild with good materials ➢ Widen the pavement and proper drainage
Bleeding	➢ Sanding, Seal Coat ➢ Local Sealing
Delamination	➢ Remove the area, clean and replace ➢ Double Chip Seal, Seal Coat, Overlay

The most failure pattern is rutting in Tada UAirport road. These failures are continuous and terrible condition. And then, the failure area is large. So, this road maintenance is not enough seal coat, need to maintain overlay method. According to Transport and Road Research Laboratory (TRRL), total deflection is exceed the allowable value of 32×10^2 mm, the overlay maintenance is required for Tada UAirport Road. The various stresses and strains of road layers are calculated by using Method of Three Layered System. So, the required overlay thickness is calculated by India Road Congress. In Tada UAirport road portion, total thickness of existing pavement is 10 inches and the required overlay thickness is 6 inches after calculated.

B. Repair Method of PaleikTada U Road

The failure patterns and suiTablerepair methods of PaleikTada U Road are shown in Table5.

Table5. Repair Methods of PaleikTada U Road Portion

Failure Patterns	Repair Methods
Pothole	➢ Base patching ➢ Filling potholes with premix materials and overlay
Map Cracking	➢ Removal of the cracked area then digging out and replacing the area with premix ➢ Overlay, Thin HMAs Overlay
Crocodile Cracking	➢ Treatment based on the severity and intensity of cracks starting using overlay, seal coat, surface patching or reconstruction ➢ Double Chip Seal
Rutting	➢ Filling the ruts using either a dense graded bituminous mix or open graded premix ➢ Seal Coat and Local Sealing
Raveling	➢ Overlay, Double Chip Seal, Thin HMAs Overlay ➢ Seal Coat and Local Sealing
Longitudinal Cracking	➢ Cut and Patch ➢ Seal Coat, Local Sealing and overlay
Depression	➢ Filling Depression, Base Patching ➢ Overlay and Thin HMAs Overlay
Corrugation	➢ Seal Coat and local sealing ➢ Reconstruction
Edge Failure	➢ Shoulder Strengthening ➢ Rebuild with good materials ➢ Widen the pavement and proper drainage
Bleeding	➢ Sanding, Seal Coat and local sealing
Delamination	➢ Remove the area, clean and replace, Double Chip Seal, Seal Coat, Overlay and Treatment

The most failure pattern is pothole in PaleikTada U road. The road is used two ways and the extended each one way width is not enough to travel two vehicles as parallel. These failures are continuous and terrible condition. And then, the failure area is large. So, this road maintenance is not enough seal coat, need to maintain overlay method. According to Transport and Road Research Laboratory (TRRL), total deflection is exceed the allowable value of 32×10^2 mm, the overlay maintenance is required for PaleikTada U Road. So, the required overlay thickness is calculated by India Road

Congress. In PaleikTada U road portion, total thickness of existing pavement is 8 inches and the required overlay thickness is 5 inches.

V. Conclusion

In this study, large number of failures and same types of failure patterns are found along Tada UAirport road and PaleikTada U road. These types of failure are map cracking, depression in flexible pavements, corrugation, rutting, longitudinal cracking, pothole, bleeding, edge failure, crocodile cracking, delamination and raveling. The localized failures are caused by pavement aging, repeat growth in traffic loading and necessary of drain. After knowing the causes of defects and failures, the maintenance method required for the forming failure patterns is determined. A pavement is maintained by either visual maintenance activities or structural maintenance activities. If the wearing course of existing road has not achieved compaction, loose binding action is found. The existing road should be maintained by structural maintenance such as overlay. In Tada UAirport road portion, the existing pavement total thickness is 10 inches and the required overlay thickness is 6 inches after calculated. In PaleikTada U portion, the road width is needed to extend and the subgrade of the existing pavement has not achieved compaction and stable, localized road failure occur. Moreover, the road is used two ways and the extended each one way width is not enough to travel two vehicles as parallel. So the existing road condition is poor. The existing road should be maintained by structural maintenance such as overlay maintenance. In PaleikTada U road portion, the existing pavement total thickness is 8 inches and the required overlay thickness is 5 inches.

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