



Investigating the Service life of asphalt pavement in a sample of Ramadi district roads

Kalid awaad

Abstract

A sample of 50 randomly selected rural and urban roads of Ramadi district were observed for asphalt pavement Distresses. Three main types of Distresses were considered; rutting, cracks and pavement separation. In addition, different other Distresses types that were observed were grouped in one category named "Other". For each road, information about the age of the pavement was recorded. Kaplan-Meier method was carried out in order to understand the Remain time before pavement deterioration as well as to compare pavement service life with respect to the type of Distress. Results of this research revealed significant differences between pavement service life corresponding to the type of Distress. Pavement service life appeared to last less than 20 months when all the mentioned types of Distresses are occurred on the road.

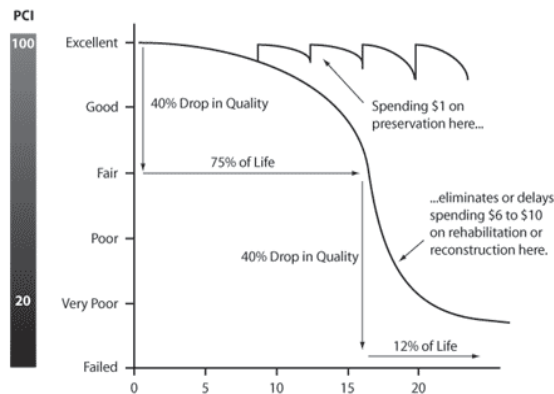
Keywords: Asphalt pavement, Lifetime, Kaplan-Meier method

الخلاصة

تم أخذ عينة عشوائية مكونة من 50 طريق ريفي و حضري تابعة لقضاء الرمادي حيث تم معاينة عيوب الاكساء الإسفلتي لهذه الطرق. لقد تم اعتبار ثلاثة عيوب رئيسية لهذا الغرض هي؛ الحفر ، الشقوق و الفصل في الاكساء الإسفلتي. بالإضافة إلى ما تقدم ذكره من عيوب فان العيوب الأخرى التي تمت ملاحظتها قد سجلت جميعها تحت مجموعة سميت "أخرى". لقد أخذت معلومات عن عمر الاكساء الإسفلتي لكل طريق تم اختياره في عينة الدراسة. استخدمت طريقة Kaplan-Meier لحساب تقدير لوقت البقاء للاكساء الإسفلتي قبل أن تحدث العيوب التي تم وصفها. أظهرت الدراسة وجود فروقات معنوية بين عمر الاكساء الإسفلتي عند تواجد عيوب مختلفة. كما أظهرت الدراسة عندما تتواجد جميع العيوب في طبقة الإسفلت ، فان هذا يؤدي إلى تقليص عمر الاكساء ليصل إلى اقل من 20 شهرا.

Introduction

Road construction is an indicator for the level of infrastructure that established to offer services that would make life more easiest. Governments spent great amounts of money in order to enhance roads networks. Such networks planned to serve for long period of times, fig. 1.



Ref.: GHD Inc. 1545 Iyannough
Road Hyannis MA 02601 USA

Fig.1. Lifetime of asphalt pavement with reference to condition.

Logically, service life of asphalt pavement depends on the degree of deterioration that appeared in the pavement¹. Deterioration of asphalt pavement found to happened to variety of causes²⁻⁴. The condition of asphalt pavement is the key that show how long the pavement will survive.

Pavement deterioration happened due to different causes²⁻⁴. The accumulation of causes on the same site of the road will certainly lead to bad condition and may needs real maintenance.

Stephen A Arhin, et al., 2015⁵ introduced an idea to predict pavement condition index in the light of international roughness index.

Reasons that contribute to the deterioration signs of asphalt pavement are mainly those that involved road abuse (allow for vehicle which exceeds upper limit of allowable load, vandalism, ..etc.), weathering, insufficient pavement material and design. One or more of these reasons will result in violation of validity of planned pavement duration.

Survival analysis⁶ is the statistical technique that can be used to understand the time distribution of any phenomenon with respect to the occurrence of a certain event. This technique was used in the context of pavement lifetime⁷⁻⁸ frequently.

In this research work, this technique will also be used with

a focus on Kaplan-Meier method of estimating the service life function of time.

Data collection and analysis

A random sample of 50 roads from urban 28 (56%) and rural 22 (44%) of the areas of Ramadi district was considered. Each road was observed for the existence of any of the following signs:

1. Rutting
2. Cracks
3. Separation
4. Other

The pavement is evaluated in excellent condition if none of the previous 4 signs appeared. On the other hand, the pavement is evaluated in bad condition if 2 or more signs appeared, otherwise it is evaluated as having a slight (Medium) deterioration.

Time since the last overlay for each road was recorded and history of previous overlay and maintenance was ignored.

It is very important to know that the layout of the

collected data involved eight variables; zone (urban/rural), life (age of the pavement), rut (0 if it is not exist and 1 if Rutting exists), crack (0 if it is not exist and 1 if Cracks exists), separation (0 if it is not exist and 1 if (separation exists), other (0 if it is not exist and 1 if Other exists), sum (the sum of the four scores), censor variable (0 if the sum equals 0 and 1 if it is not).

The IBM SPSS 20 was used to run the Survival Analysis technique with respect to the collected set of data.

Results and discussion

Table 1 shows the frequency distribution of the occurrence of pavement distresses as observed in the roads of the considered sample.

Cracks are found to be occurred in 50% of the roads of the whole sample. Rutting is found in 22 (44%) roads and pavement separation is found in 20 (40%) roads. The Chi-square test for comparing percentages revealed that only the occurrence of (rut, crack and other types of deterioration) in rural areas is significantly higher than that of the urban areas at $p < 0.05$.

Actually, such a result can be interpreted in terms of the periodical maintenance on the roads of these areas.

Table1. Frequency distribution of the defect(s) occurrence.

Distress(s)	Total	Urban	Rural
Rutting	22	10	12
Cracks	25	14	11
Separation	20	12	8
Other	22	14	8
Rut + Crack	11	4	7
Rut + Separate	11	6	5
Rut + Other	14	7	7
Crack +Separate	12	5	7
Crack +Other	14	10	4
Separate +Other	10	6	4
Rut+ Crack+ Separate	5	1	4
Rut + Crack+ Other	7	4	3
Rut+ Separate+ Other	7	3	4
Crack +Separate +Other	6	3	3
Rut + Crack+ Separate +Other	4	1	3
None	12	6	6

Less attention paid for the roads in rural areas due to the fact that these roads are not extensively used and the small ruts and or cracks will grow up and extended widely on the road before they pointed out as a real warning that threatening the condition of asphalt pavement.

Unlike urban areas, such signs may disable common traffic flow, and hence the authorized offices will take a decision in shorter time than in rural areas which help maintain the road and prevent progress of such signs that lead to pavement bad condition and failure.

The Kaplan-Meier method was used in conjunction with Survival Analysis. Comparisons of the survival curve according to the type of defects were made. Table 2 shows that survival curves of asphalt pavement differ significantly with respect to the occurrence of the defect types since the p-value is less than 0.05 for all of the tests considered in the table.

Table 2. Overall comparison of survival curves.

	Chi-Square	df	Sig.
Log Rank (Mantel-Cox)	35.62 2	4	.00 0
Breslow (Generalized Wilcoxon)	26.45 3	4	.00 0
Tarone-Ware	30.86 3	4	.00 0

Figures 2 and 3 show that survival curve when all types of defects occurs, pavement service life will not exceed 20 months for roads of urban areas, whereas it exceeds the limit of 30 months in rural areas. This is also can be interpreted in terms of the extensive use of the roads. Urban roads are more extensively used than rural roads and that make them exposed to high potential for pavement failure.

When comparing service life curves for roads with 1 distress in urban and rural areas, both zones showed approximately same distribution that last for a maximum of 30 months.

It may be seems very surprising when distribution of service life for roads with 2-3 distresses showed a service life that exceeds 30 months. This is actually because sometimes one defect resulted in a huge damage when compared to many other defects on other roads.

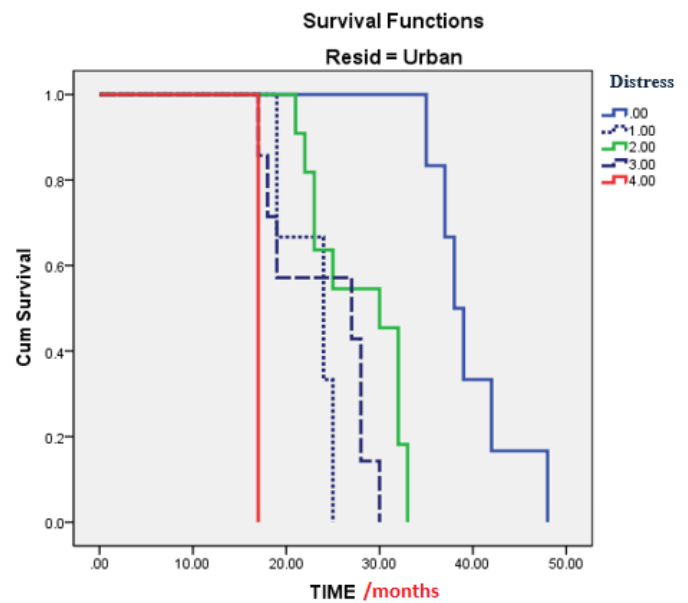


Fig.2. service life curve of urban roads with respect to number of distress.

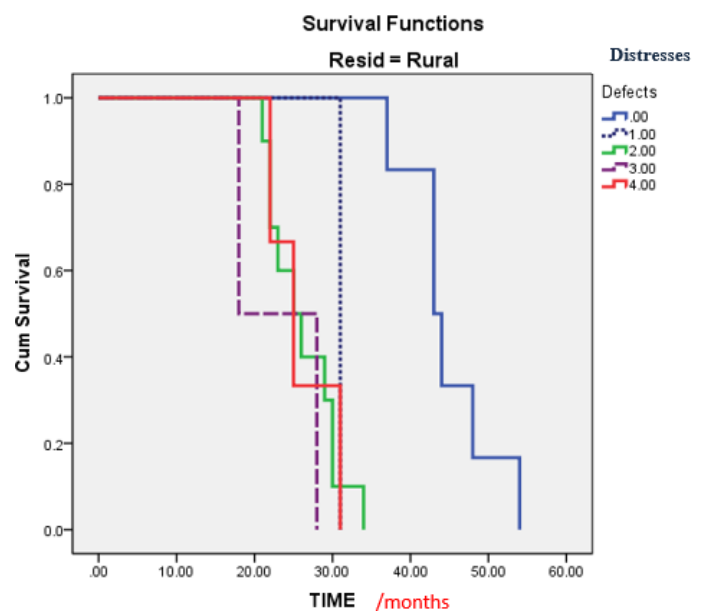


Fig.3. service life curve of rural roads with respect to number of distress.

Conclusion

Condition of asphalt pavement can be easily evaluating with respect to a certain criterion that considered type and extent of distress effects. Service life curve is not necessarily depending only on the number of distresses, but also on the extent of damaged made by the distress(s). When more than three defects happened to occur on a certain road, pavement service life will be very short and deterioration will rapidly spread.

It is very important for roads to be examined periodically for any potential progress in distresses that may be caused intentionally or accidentally.

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