



شبكة المعلومات الجامعية
التوثيق الإلكتروني والميكرو فيلم

بسم الله الرحمن الرحيم



HANAA ALY



شبكة المعلومات الجامعية
التوثيق الإلكتروني والميكروفيلم



شبكة المعلومات الجامعية التوثيق الإلكتروني والميكروفيلم



HANAA ALY



شبكة المعلومات الجامعية
التوثيق الإلكتروني والميكروفيلم

جامعة عين شمس التوثيق الإلكتروني والميكروفيلم

قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها
علي هذه الأقراص المدمجة قد أعدت دون أية تغييرات



يجب أن

تحفظ هذه الأقراص المدمجة بعيدا عن الغبار



HANAA ALY



AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING

Public Works

Developing a Mathematical Model to Evaluate Asphalt Pavement Condition for Libyan Roads

A Thesis submitted in partial fulfilment of the requirements of the degree of

Master of Science in Civil Engineering

(Public Works)

by

ELMUSTAFA. FARAJ. ALI. ELAWKALI

Bachelor of Science in Civil Engineering

(Public Works)

Faculty of Engineering, Omar Al-Mukhtar University, ٢٠١٥

Supervised By

Prof. Hassan Abd Elzaher Hassan Mahdy

Prof. Hamdy Elsayed Mohamed

Dr. Ahmed Atef Mohmaed Soliman

Cairo - (٢٠٢١)



AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
Public Works

Developing a Mathematical Model to Evaluate Asphalt Pavement Condition for Libyan Roads

by

Elmustafa Faraj Ali Elawkali

Bachelor of Science in Civil Engineering

(Public Works)

Faculty of Engineering, Omar Al-Mukhtar University, ٢٠١٥

Examiners' Committee

Name and Affiliation

Prof. Hassan Abd Elzaher Hassan Mahdy
Public Works , Ain Shams University
Prof. Eisa Abdallah Sarhan
Public Works , Ain Shams University
Prof. Sherif Massoud Ahmed El-Badwy
Public Works , Mansoura University

Signature

.....
.....
.....

Date: ٢١ December ٢٠٢١

Statement

This thesis is submitted as partial fulfilment of Master of Science in Civil Engineering Engineering, Faculty of Engineering, Ain shams University.

The author carried out the work included in this thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

Elmustafa. Faraj. Ali. Elawkali

Signature

.....

Date: 21 December 2021

Researcher Data

Name : Elmustafa. Faraj. Ali. Elawkali
Date of birth : ٢١/٠٦/١٩٩١
Place of birth : Darnah/Libya
Last academic degree : Bachelor of Science in Civil Engineer
Field of specialization : Civil Engineer
University issued the degree : Omar Al-Mukhtar University
Date of issued degree : ١٢/١٢/٢٠١٥
Current job : Maintenance Department at Irasa Modern
Technology Company

Abstract

Pavement evaluation is an essential step for pavement preservation. It is a major part of any pavement management system. The department of transportation must have an approved indicator to evaluate the pavement condition to determine the necessary maintenance procedures.

There are no methods to evaluate the Pavement in Libya; therefore, there is no pavement condition data in the competent authority. Therefore, the researcher suggests a technique for evaluating the flexible Pavement in Libya.

This study used indices of pavements evaluation such as Pavement Condition Index (PCI), International Roughness Index (IRI) and Present Serviceability Index (PSI) to obtain appropriate data. Moreover, it investigated their correlation with the Libyan Road Users' Opinion (LRUO); this was obtained by a questionnaire targeting road users.

The data showed that PSI has a moderate correlation with LRUO, while IRI did not show agreement with LRUO, but it indicated a strong relationship between the LRUO and PCI with a Pearson correlation coefficient (R) of 0.807 and coefficient of determination (R^2) of 0.652.

Moreover, the relations of PCI with other evaluation methods are strong, with a correlation coefficient of 0.828 and -0.734 for PSI and IRI. Also, was developed a PCI model according to LRUO and IRI with R^2 of 0.90, Standard error of 1.9. Thus, the PCI can be determined more quickly and simply through LRUO and IRI.

Finally, a mathematical model was developed for the Libyan road pavement index(LRPI), based on PCI and IRI with R^2 of 0.90 and a stander error of estimate of 0.40.

Keywords:

Pavement Evaluation, PCI, PSI, IRI, Road Users

Acknowledgement

First of all, I want to thank Allah for helping me to complete this work successfully. Then, I want to thank my parents for all the sacrifices

Also, supervisors for their help and advice, despite their busy schedules. I am proud to complete this thesis under their supervision. I want to thank **Prof. Hassan Mahdy** for his great encouragement and support. I also want to thank **Dr Hamdy Elsayed** for his instructions and encouragements

I would like to extend my sincere thanks and respect to **Dr Ahmed Atef Mohamed Soliman**, who helped and supported me with his guidance, experience and his vast knowledge to finish this work.

Having supervisors as my supervisors are very productive. Their care, support and encouragement are greatly appreciated. All the door was always open to my questions, problems and advice.

Many thanks to the team of friends who helped me collect field data in my wonderful country Libya.

Last but not least, thanks to all staff members and colleagues of the public works department, Ain Shams University, for their kind help.

December ٢٠٢١

Table of Contents

Statement	IV
Researcher Data.....	V
Abstract	VI
Acknowledgement.....	VII
Table of Contents.....	VIII
List of Figures	X
List of Tables.....	XII
List of Abbreviations.....	XIII
Chapter One: Introduction.....	1
1.1 Overview.....	1
1.2 Problem Statement.....	2
1.3 Research Objectives	2
1.4 Research Plan.....	3
1.5 Thesis Organization	5
Chapter Two: Literature Review.....	6
2.1 Overview	6
2.2 Flexible Pavement.....	6
2.3 Structure of The Flexible Pavement	8
2.4 Failure Causes of Flexible Pavement.....	9
2.5 Flexible Pavement Distresses	10
2.6 Evaluation of Flexible Pavement	11
2.7 Flexible Pavement Preservation.....	14
2.8 Road User Opinion as Evaluation Scale	16
2.9 The Relationship Between IRI and PCI.....	17
Chapter Three: Methodology	20

3.1 Overview	20
3.2 Roads Selection	21
3.3 Questionnaire	22
3.4 Distress Measurement	25
3.4.1 Equipment of Measurement	26
3.4.2 Measurement procedure	26
3.5 Pavement Condition Index calculations.....	27
3.6 International Roughness Index Measurement.....	27
3.7 Present Serviceability Index calculations	29
3.8 Correlations Analysis and Regression Model.....	30
Chapter Four: Results and Discussion	31
4.1 Introduction	31
4.2 Questionnaire Results	31
4.3 Pavement Condition Index.....	31
4.4 International Roughness Index	39
4.5 Present Serviceability Index.....	44
4.6 Correlation Results.....	48
4.6.1 Correlation.....	49
4.6.2 Stepwise Linear Regression Model.....	51
Chapter Five: Summary, Conclusion, And Recommendation.....	55
5.1 Summary	55
5.2 Conclusions	56
5.3 Recommendation	57
References	59
Appendix A	65
Appendix B.....	98

List of Figures

Figure 1.1	Research Plan Flow-chart	4
Figure 1.2	Flexible Pavement Distress Groups	10
Figure 1.3	Pavement Evaluation Types	11
Figure 1.4	activities of maintenance and rehabilitation	17
Figure 1.5	The location of each sample	22
Figure 1.6	Numbered photos were used for Q ₁₁ & Q ₁₂ in the questionnaire	23
Figure 1.7	The questionnaire.....	24
Figure 1.8	Datasheet from ASTM D 7432.....	26
Figure 1.9	Totalpave mobile	28
Figure 1.10	Totalpave software in pc.....	28
Figure 2.1	Mean of LRUO for each road.....	33
Figure 2.2	PCI ber Sechton for Jalu Road.....	36
Figure 2.3	PCI ber Sechton for Ajdabya Road	36
Figure 2.4	PCI ber Sechton for Aljaghbub Road.....	36
Figure 2.5	PCI ber Sechton for Martuba Road	37
Figure 2.6	PCI ber Sechton for Qasr Libya Road	37
Figure 2.7	PCI ber Sechton for Ajkhira Road.....	37
Figure 2.8	PCI ber Sechton for Albayda Road	37
Figure 2.9	PCI ber Sechton for Krsa Road	37
Figure 2.10	PCI ber Sechton for Altmymy Road	37
Figure 2.11	PCI ber Sechton for Amsaeid Road.....	38
Figure 2.12	IRI ber Sechton for Jalu Road	40
Figure 2.13	IRI ber Sechton for Ajdabya Road	40
Figure 2.14	IRI ber Sechton for Aljaghbub Road.....	40
Figure 2.15	IRI ber Sechton for krsa Road	41
Figure 2.16	IRI ber Sechton for Qasr Libya Road	41
Figure 2.17	IRI ber Sechton for Ajkhira Road	41
Figure 2.18	IRI ber Sechton for Albayda Road	42
Figure 2.19	IRI ber Sechton for Altmymy Road	42
Figure 2.20	IRI ber Sechton for Martuba Road	42

Figure 4.11 IRI per Section for Amsaeid Road	43
Figure 4.12 PSI per Section for Jalu Road.....	40
Figure 4.13 PSI per Section for Ajdabya Road.....	40
Figure 4.14 PSI per Section for Aljaghbub Road	40
Figure 4.15 PSI per Section for Krsa Road.....	47
Figure 4.16 PSI per Section for Qasr Libya Road.....	47
Figure 4.17 PSI per Section for Ajkhira Road	47
Figure 4.18 PSI per Section for Albayda Road.....	47
Figure 4.19 PSI per Section for Altmymy Road.....	47
Figure 4.20 PSI per Section for Martuba Road.....	47
Figure 4.21 PSI per Section for Amsaeid Road	48
Figure 4.22 Pearson Correlation graphs.....	41
Figure 4.23 PCI (Estimated and Measured) for Model 1	44
Figure 4.24 PCI (Estimated and Measured) for Model 2	44