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ASSESSMENT OF HIGHWAY PAVEMENT DISTRESSES SUBJECTED TO OVERLOADING IN HILLA CITY: A ROAD NO. 80 CASE STUDY

Alia Jasem AL-Janabi[1] and Asst . Prof. Hayder Abbas Obaid[2]

[1] Civil Department/ Engineering College/Babylon University /Babil, Iraq
Email: Alia.zughayer.engh401@student.uobabylon.edu.iq
ORCID: https://orcid.org/0009-0008-7179-3622

[2] Civil Department/ Engineering College/Babylon University /Babil, Iraq
Email: eng.hayder.abbas@uobabylon.edu.iq
ORCID: https://orcid.org/0000-0002-5616-9935ABSTRACT

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ABSTRACT:

Roadway pavements constitute a vital component of transportation infrastructure, and their effective maintenance and rehabilitation are paramount to ensure optimal functionality. Efficient road management systems save time and resources and rely on accurate pavement condition surveys. To ensure optimal functionality, it is crucial to establish a pavement management system (PMS) that involves assessing the current state of the road network and predicting future conditions. In this research, we assessed the effectiveness of asphalt pavements using two well-known approaches: The Present Serviceability Index and The Pavement Condition Index (PCI). The PCI, a numerical index, is a reliable indicator to assess the operational condition and structural reliability of pavements based on visual assessments of distress type, severity, and quantity. We aimed to classify the various types of distress observed on Road No.80 and estimate the pavement condition index. We identified nine out of nineteen distress problems in the pavement section under study through a comprehensive pavement distress condition rating approach. The most prevalent distress types included longitudinal and transverse cracking, rutting, potholes, edge cracking, alligator cracking ,patching and weathering and raveling.

KEYWORDS:

Asphalt Pavement Distresses, Present Serviceability Index (PSI), Pavement Condition Index (PCI), Network-level Pavement Management, Road Maintenance, Rehabilitation Strategies.

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1. INTRODUCTION

Flexible pavements are susceptible to various factors that affect their performance and serviceability, such as excessive traffic loads, temperature variations, water infiltration, design errors, and inadequate maintenance practices (Adlinge and Gupta, 2013). In Iraq, where temperatures may exceed 50°C, uncontrolled traffic loads and inadequate maintenance management plans have resulted in severe pavement deterioration. The main causes of highway network failure in the middle of Iraq are rapid deformation due to the lack of periodic maintenance, increased traffic weights and repetitions, weak subgrade, inadequate drainage systems, and poor asphalt mixture design (Alwan, 2013; Alwan, 2015).

The poor execution and design of road layers, low-quality asphalt wearing course, reduced thickness, insufficient compaction, and other factors have contributed to distress in the roadways of Hilla City (Alwan, 2013; Alwan, 2015).

Studies conducted in Iraq have shown that typical pavement distresses in the region include longitudinal and transverse cracking, rutting, potholes, edge cracking, raveling, bleeding, and alligator cracks (Kadhim and Mahdi, 2018). The State Commission for Roads and Bridges reports that over 70% of the existing road networks in Iraq is in poor condition and requires maintenance (Sarsam, 2016). Although the Ministry of Housing and Construction has developed repair plans, the execution is hindered by limited funding and a lack of adherence to prioritized schedules (Sarsam and Abdulhameed, 2014).

To address these issues and optimize pavement management, developing a robust road maintenance management system is crucial (Mohamed, 2010). Pavement condition surveys play a significant role in the Pavement Management System, providing essential information for assessing pavement serviceability, estimating maintenance and rehabilitation needs, prioritizing actions, and allocating financial resources (Youssef and Elbasher, 2014). One key variable in determining pavement repair needs is pavement distress, which reflects the surface condition (Garber, Hoel and Sarkar, 2002).

Pavement condition rating systems, such as the Pavement Condition Index (PCI), offer an effective method for assessing the state of a pavement (ASTM, 2009). The PCI, initially developed by the US Army Corps of Engineers and later adopted by professional associations, assigns a numerical value based on the type, intensity, and extent of distress found on the pavement (Sidess, Ravina and Oged, 2021). Additionally, the Present Serviceability Index (PSI) is used to evaluate newly constructed or rehabilitated roadways, with specific PSI ranges indicating the pavement's condition and level of failure (Al-Khateeb and Khadour, 2020).

The pavement serviceability index (PSI) is one of the pavement performance metrics originally used in the AASHO (now AASHTO) road test to assess pavement quality. The PSI is significantly connected with the roughness index, which is now used to forecast pavement performance in the Mechanistic-Empirical Pavement Design technique. As a result, PSI is still regarded as a significant metric for assessing pavement performance (Shahin, 2005).

This study aims to investigate and assess the distresses in asphalt pavements using the PCI and PSI indices. By analyzing the pavement condition and identifying the number and types of defects, where aims to contribute to understanding and managing asphalt pavement distresses in the context of Hilla City.

2. STUDY AREA DESCRIPTION

The study focuses on Highway No. 80, located in Iraq's Babylon province, as the specific area of investigation. Highway No. 80 , constructed in late 2010, serves as a vital link connecting the Hilla-Karbala road with the Hilla-Najaf road. The road comprises multiple layers, including the binder, base, and subbase, with 6 cm, 12 cm, and 30 cm thicknesses. The pavement design follows a flexible pavement type Spanning a length of approximately 10.60 km, Road No. 80 extends from Karbala - Hilla to Hilla - Najaf. The road features three lanes in each direction, measuring 3.65 m in width.

Additionally, the road includes a shoulder width of 2.0 m on either side (Hilla Municipality). This case study provides valuable insights into the structural evaluation and enhancement of pavement performance on this roadway by examining and assessing the distresses in asphalt pavements using the PCI and PSI indices by analyzing the pavement condition and identifying the number and types of defects, which contributes to understanding and managing asphalt pavement distresses in the context of Hilla city. The findings will contribute to developing effective strategies for optimizing pavement design and extending the service life of flexible

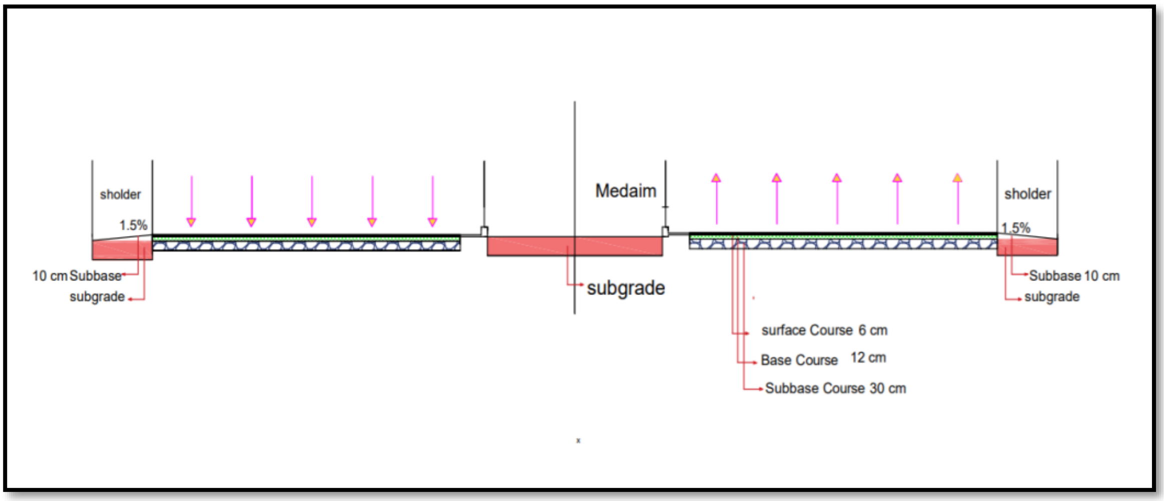


Fig. 1. Typical cross section for Road No.80

pavements in similar high-traffic areas in Iraq and beyond. Table 1 presents the structural properties, and Fig.1 shows a typical cross-section of Road No. 80.

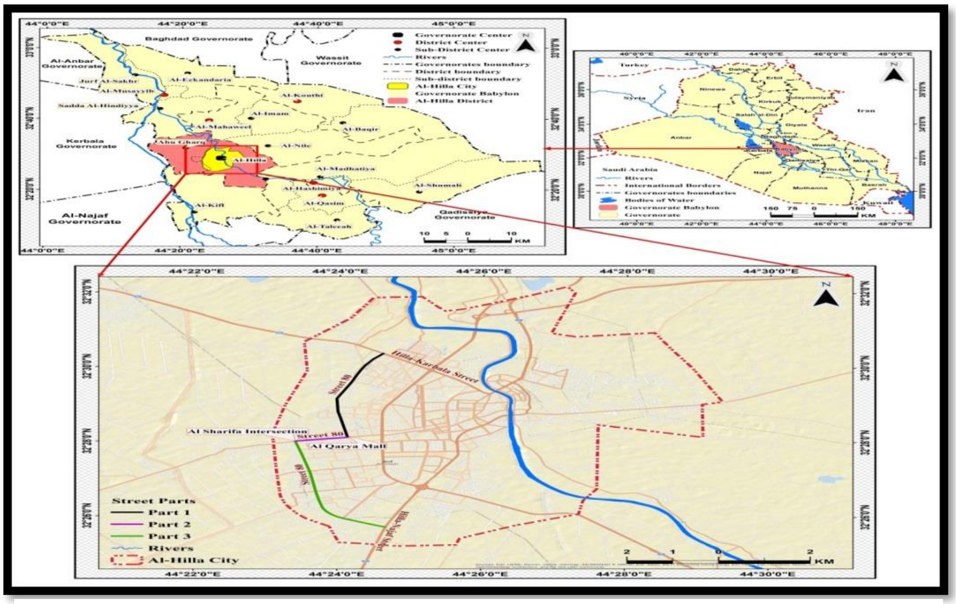


Fig. 2 Study Area (Road No. 80)

3. METHODOLOGY

The fundamental prerequisite for every pavement management and maintenance activity is knowledge of the pavement's situation. Consequently, a systematic approach to evaluate the pavement's condition is required. A judgment regarding the necessity for repair can only be made when the state of a pavement has been determined. Fig. 2 depicts graphically how the Pavement Condition Index and present serviceability index are measured or evaluated.

3.1. Survey of Pavement Condition

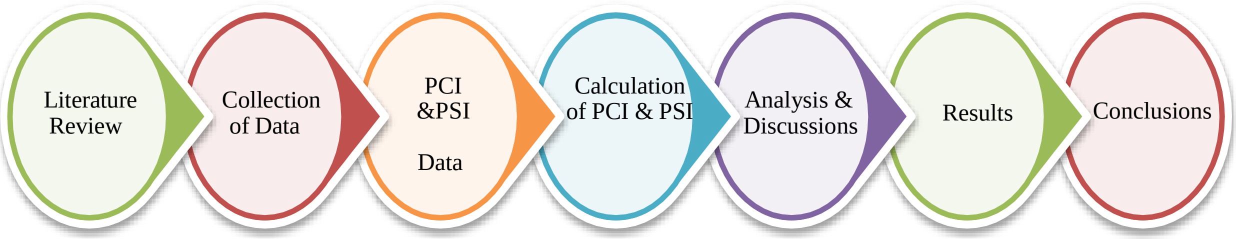


Fig. 3 The Flowchart for Evaluation of PCI

Before evaluating the PCI (Pavement Condition Index), a series of processes must be undertaken. To complete the subject task, namely the actual evaluation of PCI, the following three stages must be taken:

- Definition of a Pavement Network
- Measurement or survey of pavement condition

- PCI determination

3.1.1. Pavement Network Definition

- Network Definition

The network comprises Road No. 80 and consists of three sections:- section one starts from Karbalaa Roadway to Tuhmaziya Roadway with a length of (4.5 km), section two starts from Al-Tuhmaziya Roadway to the Shirefaa intersection with a length of (1.2 km), and section three starts from Shirefaa intersection to Najaf roadway with length of (4.9 km) This highway links important cities of Hilla city, and several towns & villages around it.

- Branch & Section

A branch is an easily identifiable section of a network with a specific purpose. Using the current name ID system seen on the maps maintained by the maintaining agency is a simple method of classifying the branches that make up the pavement network.

A branch does not usually have consistent features over its whole area or length because it is typically a major element of the pavement network. For managerial reasons, branches are often split up into smaller units known as sections. When it comes to applying and choosing maintenance and rehabilitation treatments, a section is the smallest management unit. Every branch has a minimum of one part, however, if the pavement qualities differ across the branch, there may be more sections.

3.1.2. Measurement or Survey of Pavement Condition

- Sampling and Unit Size

The roadway surface type determines the steps in a performance pavement condition index (PCI) surveying as they vary based on it. The pavement segment must be divided into several sample units for all surface types. The size of a pavement sample unit depends on the type of pavement section it is a part of AC pavement, and has an area of 225±90 m2 (2500±1000 ft2) (Shahin, 2005). The area of the section taken in the study area is 297 m2. A sample plan is used to generate a somewhat exact pavement condition index for the PAVER system while only evaluating a small number of sample units in each segment. The quantity of samples required is determined by using the pavement and the project or network level. For the administration in the project level, precise data is needed to create contracts and work procedures. Therefore, more sample units than generally examined for network-level management were analyzed.

The main stage in the sampler procedure is to

1- Calculate the smallest sample unit's number (n). This number must be examined to determine the section's PCI. As a reasonable prediction of the section's PCI, the minimal number was calculated using the curves shown in Fig. 4. Since the mean PCI is 5 points lower than the evaluated value, the confidence level is 95%. To

be clear, genuine PCI is derived after surveying every sample unit. Fig.4 shows curves that are produced using Equation (1).

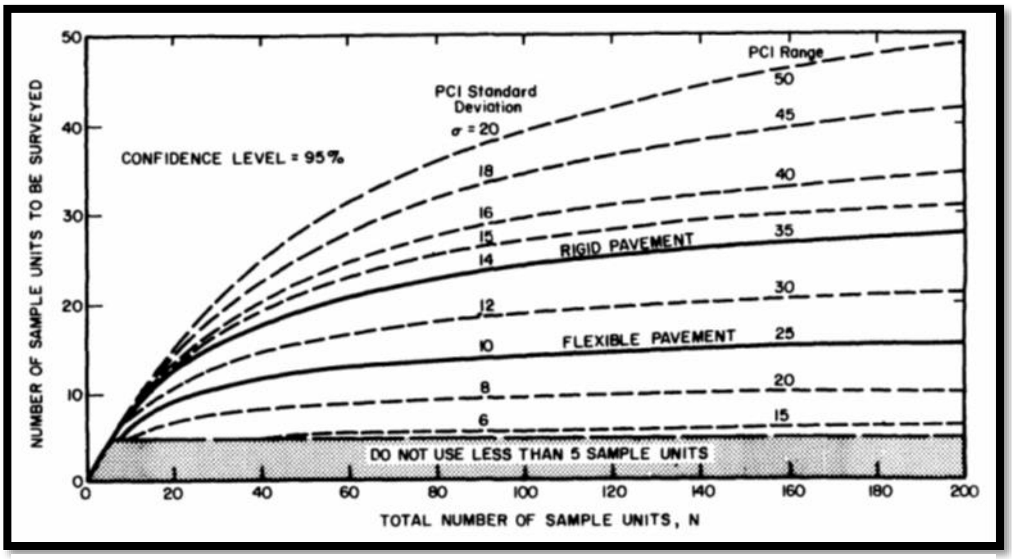


Fig. 4 Minimum Sample Units Required (AASHTO,1993; Hameed, 2021).

$$n = \frac{N * S^2}{(e2/4)\,(N-1)+S^2} \qquad (1)$$

Where:

S: Is the PCI standard deviation from one sample unit to the next inside the segment. It uses 10 for AC pavements but takes 15 for PPC pavements.

e: is the allowable error in predicting the PCI of the segment (e = 5).

N: is the total sample unit count in the pavement segment. calculated from equation (2)

$$N = \frac{\text{Area of section}}{\text{Area of sample}} \qquad (2)$$

For section from **Karbalaa Roadway to Tuhmaziya Roadway**

Area of section = 11m (width) * 1000m (length) = 11000 m^2

A sample unit area of 297m^2 will be used for a 11 m width.

Length of every unit in the segment 297/11 = 27 m .

N = $\frac{\mathbf{11000}}{\mathbf{297}}$ = 37 (total sample units' number)

n =$\frac{\mathbf{37*100}}{\left(\frac{\mathbf{25}}{\mathbf{4}}\right)*(\mathbf{37-1})+\mathbf{100}}$ =11 (minimum number of samples)

As a result, 11 random sample units were used to assess each section of pavement in the study region.

- Selecting Sample Units

The initial sample is chosen using a "systematic random" technique, and the distances between the sample units that will be examined must be uniform across the segment (Shahin,2005). The following techniques were used to explain this method:

A. The sampling interval (i) is calculated using the formula (i = N/n), where (N) is the total number of sample units that can be obtained and (n) is the smallest number of sample units that must be inspected. The sampler interval (i) is rounded to the lowest limit (3.6 is converted to 3.0, for example).

B. The sampling interval (i) and the random start (S) are determined randomly. For instance, the random start would be an integer between 1 and 3 if i = 3.

C. The survey's sample units are S, S+i, S+2i, etc. The sample units to be inspected are 6, 9, 12, etc., if the chosen start is 3 and the sample interval is 3. . Regarding the first section of the chosen case study:

I = N/n = 37/11 = 3

The first sample to be examined is sample 3 because i=3 , and the subsequent samples will be as follows and as shown in Fig.5 :

3,3+3, 3+2*3, 3+3*3……..

3, 6, 9, 12, 15, 18, 21, 24,….

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
22	23	24	25	26	27	28	29	30	31	32	33									

Random start (S) = 3 , S+ i = 6

Fig. 5. Identifies the position of sample units that require inspection.

For the study area, the total sample units and inspected units are shown in Table 1.

Table 1. Information of each Section in the Study Area for PCI calculation

Road name	Direction	Road length	Road width	sample unit area(m^2)	Section count	Total sample (N)	Sample surveyed (n)
Road No.80	From Karbalaa Roadway to Tuhmaziya Roadway	4.5 km	11m	297	5	166	52
	From Al-Tuhmaziya Roadway to shirefaa intersection	1.2 km	11m	297	1	44	12
	From Shirefaa intersection to Najaf roadway	5.9 km	11m	297	5	185	55

3.2. Overall Extrapolated Defects Quantities for Pavement Section

Following extensive work on the extrapolation of pavement defect amounts for each defect kind and intensity, additional processing is required to acquire total defects quantities for various defect kinds and intensity and estimation of the overall impacted area of the pavement section under consideration. The table below summarizes the above processing to assist in estimating the needed amounts where The distress types of asphalt pavement flaws can be identified severity based on how they appear (David,2006).

Table 2. Summary of defects for section one

Defect Severity					
Defect Type	Distress Description	Unit Area	Low	Medium	High
1	Alligator Cracking	m^2	14	26	88
7	Edge Cracking	m.L	20	48	10
10	Long. & Trans. Cracking	m.L	249	183.5	142
11	Patching & Utill. Cut Patching	m^2	35	26	88
13	Potholes	Number	30		6
15	Rutting	m^2	150		
19	Weathering& Raveling	m^2	100	85	
	Total		598	368.5	334
	Grand total			1300.5	
	Density of Extrapolated Distress area = 2.63/49500 *100			2.63%	

m^2: Square meters m .L : meter. Length

Table 3. Summary of defects for section two

			Defect Severity		
Defect Type	**Distress Description**	**Unit Area**	**Low**	**Medium**	**High**
1	Alligator Cracking	m^2	5	24	
7	Edge Cracking	m.L			9
10	Long. & Trans. Cracking	m.L	100		15
11	Patching & Utill. Cut Patching	m^2		72	
13	Potholes	Number	13		6
15	Rutting	m^2			190
19	Weathering & Raveling	m^2	200		
	Slippage			18	
	Total		318	114	220
	Grand total			652	
	Density of Extrapolated Distress area = 652/13200 *100			4.9%	

Table 4. Summary of Defects for Section Three

			Defect Severity		
Defect Type	**Distress Description**	**Unit Area**	**Low**	**Medium**	**High**
1	Alligator Cracking	m^2	38	47	120
5	Corrugations	m^2	10	60	
7	Edge Cracking	m.L	55	100	10
10	Long. & Trans. Cracking	m.L	285	106	183.5
11	Patching & Utill. Cut Patching	m^2	100	140	67
13	Potholes	Number	70	2	21
15	Rutting	m^2	100		
16	Slippage	m^2		100	44
19	Weathering& Raveling	m^2	216	200	
	Total		874	755	445.5
	Grand Total			2074.5	
	Density Of Extrapolated Distress Area = 2074.5/49500 *100			4.2%	

3.3. Distress Area Quantities Evaluated for Road No.80

Extrapolated defect area quantity calculation is a closely related and significant indication of defect. The extrapolated distress area is often used to calculate maintenance costs. As a result, for Road No. 80, defect amounts in the Low, Medium, and High severity levels have been estimated in Table 5. The results are summarized here;

Table 5. Summarizes Distress Severity for Road No. 80

Road No. 80	Severity			Total	Density%
	Low	Medium	High		
Section 1	598	368.5	334	1300.5	2.63
Section 2	318	114	220	652	4.9
Section 3	874	755	445.5	2074.5	4.2

3.4. Present Serviceability Index

According to AASHTO (1993), the PSI of a new constructed or rehabilitated roadway should fall within the range of (4.5-4.2), whereas a PSI number that falls within the range of (2.5-2.0) indicates that the pavement has failed. Concurrently, a newly constructed or restored roadway's Pavement Condition Index (PCI) is set at 100, and pavement failure occurs when the value drops to 2.5 or lower. The dependence of the PCI and PSI on each other can be represented as an equation and can be found between these two domains in Equation (3) and Table 6 (Al-Khateeb and Khadour, 2020).

$$PCI = 27.510*PSI - 16.691 \quad (3)$$

Table 6. Qualitative evaluation of the pavements based on PSI and PCI. (Al-Khateeb and Khadour, 2020)

PSI Value Range	PCI Value Range
3.7-4.2	85-100
2.7-3.2	55-70
2.0-2.7	40-55
1.5-2.0	25-40
≤1.5	≤ 25

PSI scale between (0-5)

PCI scale between (0– 100)

4. RESULTS AND DISCUSSION

4.1. Calculation of The Pavement Condition Index Manually

The Pavement Condition Index (PCI) for the entire pavement segment was manually calculated based on the inspection data obtained from the sample units. Each sample unit was assigned a deducting value representing the influence of the observed distress on the pavement's condition. In this study, we focused on segment (1) of Road No. 80, which consists of 11 sample units inspected at random intervals (i=3). The specific distress types and their quantities in this segment are presented in Table 7.

The distress types identified in segment (1) include patching (20 instances, high severity), alligator Crack (5 instances, high severity), edge crack (10 instances, medium severity), transverse cracking (12 instances, high severity), pothole (1 instance, low severity), and longitudinal cracking (5 instances, low severity).

By considering the deducting values associated with each distress type, we calculated the PCI for segment (1) of Road No. 80.

Table 7. Some distress in the study area with their quantity in the section one (From Karbala –Hilla to Mall Qariya)

Sample Unit No.	Distress type	Level of Severity	Quantity
3	Patching	High	20
	Alligator Crack	High	5
	Edge Crack	Medium	10
6	Patching	High	12
	Transverse Cracking	Low	10
	Pothole	Low	1
9	Alligator Crack	High	6
	Pothole	Low	1
	Transverse Cracking	Medium	8
12	Edge Crack	Medium	30
	Longitudinal Cracking	Medium	3
15	Longitudinal Cracking	Low	5
	Transverse Cracking	Medium	3
	Patching	Medium	6
18	Pothole	High	3
	Longitudinal Cracking	Medium	10
	Pothole	Low	3
21	Patching	Low	20
	Pothole	Low	1
24	Longitudinal Cracking	Medium	10
	Pothole	Low	2
	Patching	Medium	10
27	Pothole	Medium	1
	Longitudinal Cracking	Medium	15
30	Edge Crack	Medium	10
	Longitudinal Cracking	Medium	10
33	Longitudinal Cracking	Medium	6
	Pothole	Low	2

For unit 3as a detailed example:

$$\text{Distress density (\%)} = \frac{\textbf{total quantity of distress}}{\textbf{unit area}} * 100 \qquad (4)$$

Density (%) for (Patching H) $= \frac{20}{297} * 100 = 6.7$ %

Density(%) for (Alligator Cracking H) $= \frac{\mathbf{5}}{\mathbf{297}} * 100 = 1.68$ %

Density(Edge Crack M) $= \frac{\mathbf{10}}{\mathbf{297}} * 100 = 3.4$ %

The deduct value for each type of distress was found to be equal to (42,35 and 14) for patching and Alligator crack, and Pothole while Table 8 summarizes these calculations.

After that, the maximum allowable number of deducts can b value determine as shown:

(mi)= 1+ (9/98) (100- HDV) (5)

Table 8. Conditional Survey Data Sheet for PCI Calculation

Conditional Survey Data Sheet for Sample Unit of Road No. 80

Branch: Road No.80 Section Number: 1. Sample unit: 3

Surveyed By: A.J .Date 15-10-2022 ....Sample Area: 297 M^2

1-Aligator Cracking	**6-Depression**	**11-Patching &Unit Cut Patching**	**16-Shoving**
2-Bleeding	**7- Edge Cracking**	**12-Pollshed Aggregate**	**17-Slippage cracking**
3-Block Cracking	**8- Jt Reflection Cracking**	**13-Potholes**	**18- Swell**
4-Bumpand Sags	**9-Lane Shoulder Drop off**	**14-Railroad Crossing**	**19-weathering and Raveling**
5- Corrugation	**10-Long & Trans Cracking**	**15 Rutting**	

Distress Severity	Quantity	Density %	Deduct Value	Total Deduct Value	91
11 H	20	6.7	42	Corrected Deduct Value	58
1 H	5	1.68	35	PCI=100-Corr. Dedu. Val. =100-58	42
13 L	1	0.3	36	Pavement Condition	Poor

(mi) = 1+ (9/98) (100- 42) = 6.32

The mi value (6.32) is greater than (q =3), so the corrected deduct value (CDV) can be determined using Fig. 9 where q = 3 & total deduct value (TDV)= 91 (42+35+14). The CDV obtained was 42. Finally, the PCI value for this unit is determined by (100-58) =42. Table 9 shows the hand calculations for PCI for each unit within Section No. (1).

As stated in Equation (6), the PCI for this segment is determined by averaging the PCIs of the sample units examined (Al-Khateeb and Khadour, 2020).:

$$\mathbf{PCI} = \frac{\textbf{PCIs for all sample units}}{\text{No.of sample units}} \qquad (6)$$

$$\mathbf{PCI} = \frac{\mathbf{42+70+60+84+92+46+84+72+80+82+86}}{\mathbf{11}} = 72.54$$

Repeating the previous procedure described for PCI calculation, the PCI values for each segment with in study area were calculated and summarized in Table 10 and shown in Fig. 10.

Table 9. The PCI Values Estimation for Each Sample Unit for the (Road No.80)

Unit No.	Distress Type	Quantity	Density	Deduct Value	m_i	q	TDV	CDV	PCI
3	Patching	20	6.7	42	6.32	3	91	58	42
	Alligator Cracking	5	1.68	35					
	Edge Crack	10	3.4	14					
6	Patching	12	4	34	7.06	3	50	30	70
	Transverse Cracking	10	3.4	2					
	Pothole	1	4	14					
9	Alligator Crack	6	3.4	40	6.51	3	62	40	60
	Pothole	1	0.04	14					
	Transverse Cracking	8	2.7	8					
12	Edge Crack	30	10	24	7.98	2	26	16	84
	Longitudinal Cracking	3	1	2					
15	Transverse Cracking	5	1.7	0	8.90	3	17	8	92
	Longitudinal Cracking	3	1	3					
	Patching	6	2	14					
18	Pothole	3	0.1	56	5.04	3	84	54	46
	Longitudinal Cracking	10	3.4	8					
	Pothole	3	0.1	20					
21	Patching	20	6.7	12	9.08	2	22	16	84
	Pothole	1	0.04	10					
24	Longitudinal Cracking	10	3.4	10	8.53	3	44	28	72
	Pothole	2	0.07	16					
	Patching	10	3.4	18					
27	Pothole	1	0.04	18	8.53	2	28	20	80
	Longitudinal Cracking	15	5	10					
30	Edge Crack	10	3.4	14	8.9	2	24	18	82
	Transverse Cracking	10	3.4	10					
33	Longitudinal Cracking	6	2	5	8.71	2	21	14	86
	Pothole	2	0.07	16					

Table 10. PCI values calculated Manually for Road No.80

Road Name	Direction	Section No.	PCI	Pavement Condition
Road No.80	From Karbala –Hilla to Mall Qariya)	1	72.54	Satisfactory
		2	69.4	Fair
		3	76.2	Satisfactory
		4	72.2	Satisfactory
		5	63.5	Fair
	From Mall Qariya to Shariefa Intersection	1	63	Fair
	From Sharifa Intersection to Hilla - Najaf	1	59.64	Fair
		2	60.2	Fair
		3	68	Fair
		4	66	Fair
		5	64.91	Fair
		Average	65.84	Fair

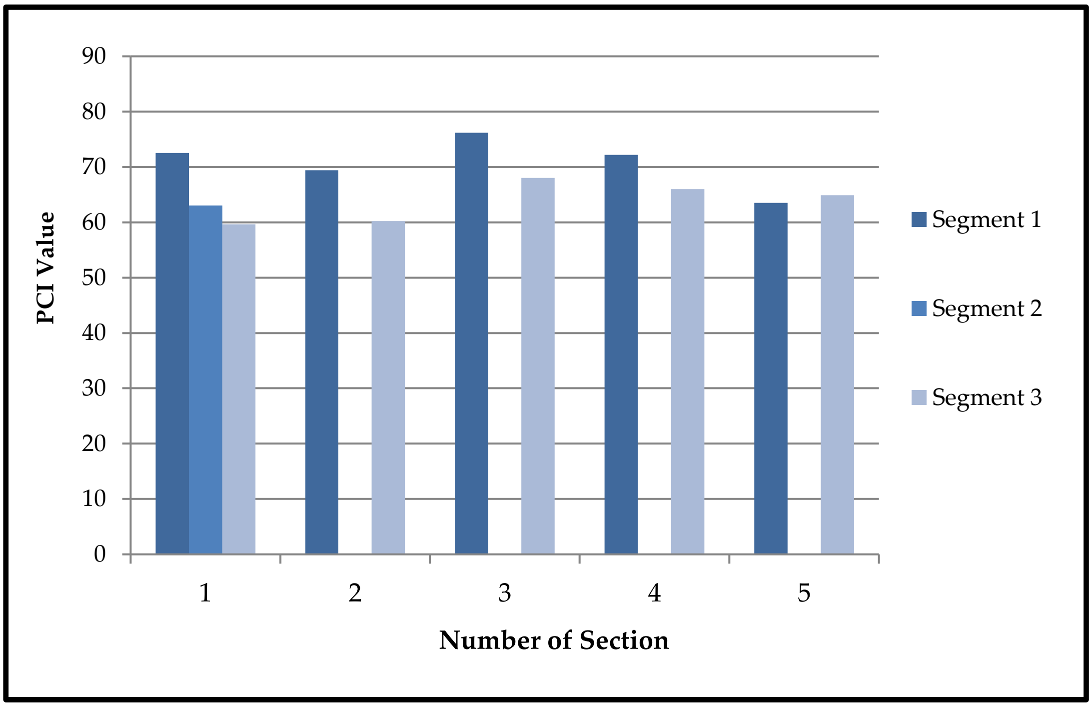


Fig. 10. PCI values of all road segments in direction (From Karbala- Hilla - to Najaf – Hilla)

4.2. Extrapolation of Distress Areas for Road No. 80

It appears reasonable to assume that the developing of distress begins with low intensity and progresses to medium and high severity over time. However, more low intensity defects continue to accumulate depending on pavement design, construction quality, loading, and maintenance &rehabilitation procedures as present in Table 11.

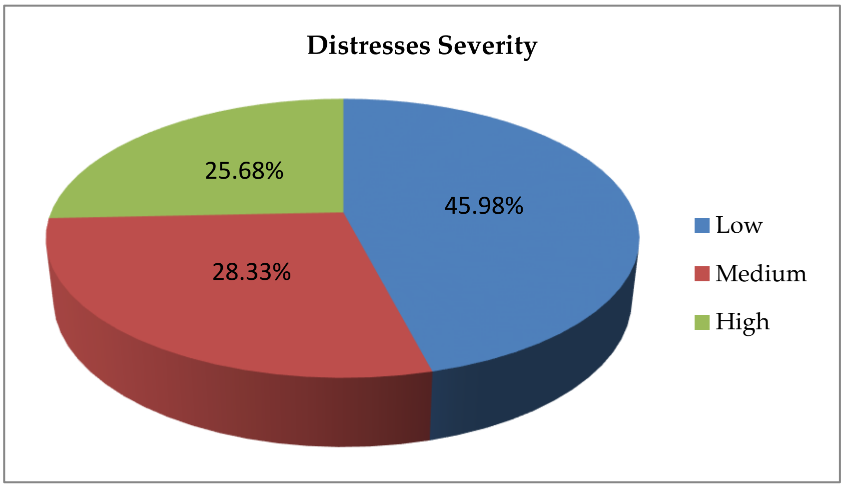
Table 11. Summary of extrapolated distress composition quantities for the three sections of the study area

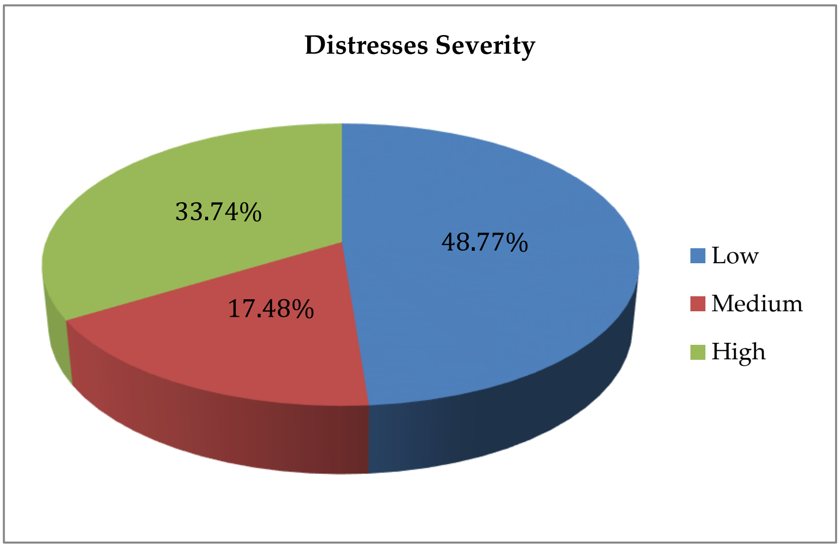
Road No.80	Severity			Total
	Low	Medium	High	
Composition of Distress Severity for section 1	45.98%	28.33%	25.68%	100%
Composition of Distress Severity section 2	48.77%	17.48%	33.74%	100%
Composition of Distress Severity section 3	42.13%	36.39%	21.48%	100%

Analysis of the defect compositions in terms of low, medium, and high severity shows that the highest incidence is Low severity for the second and first sections (45.98% 48.77%), followed by medium severity for the third and first sections (36.39%,28.33%), and high severity is for section two and one (33.74%,25.68%) are respectively as shown in Fig.11.

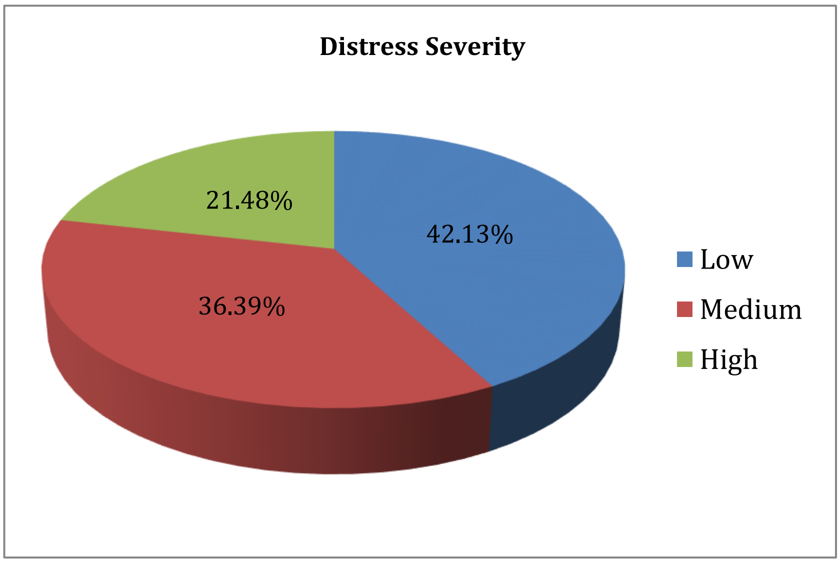
Table 12. Pavement section defect kinds in order of defect density

Total Area of all sections = 116,600m^2					
Defect Type	**Defect Description**	**Unit area**	**Defect area**	**Defect Density**	**Reasons of Defect**
1	Alligator Cracking	m^2	362	0.31	Load
5	Corrugations	m^2	70	0.06	Load
7	Edge Cracking	m	245	0.22	Load
10	Long. & Trans. Cracking	m. L	1264	1.08	Climate/Durability (poorly constructed paving lane joint)
11	Patching & Utill. Cut Patching	m^2	528	0.45	All
13	Potholes	Number	148	0.13	Load(abrasion of small pieces of pavement surface by traffic)
15	Rutting	m^2	440	0.38	Load / Material
17	Slippage Cracking	m^2	162	0.14	All
19	Weathering & Raveling	m^2	801	0.69	Durability (poor quality mixture)/ Material(asphalt binder has hardened appreciably)
	Total		4029	3.46%	





(b): Section Two



(c): Section Three

Fig. 11. Distress Compositions for Road No.80 in direction (Karbala- Hilla to Hilla- Najaf)

4.3. Present Serviceability Index

Table 6 displays the outcomes of the current serviceability index. It is important to note that the AASHTO test specifies an initial serviceability of 4.2 for flexible pavement. The expressway exhibits a terminal serviceability of 3, the major road has a serviceability of 2.5, and the minor road has a serviceability of 2. The findings imply a poor rating, indicating that all roads necessitate maintenance as they have either reached or are approaching the end of their serviceability.

Considering the PCI values, Table 13 summarizes the PSI values for all sections. The average PSI for Road No. 80 is 3. This suggests that the serviceability level requires enhancement through appropriate maintenance measures.

Table 13. The Value of (PS1) for Road No.80

Road Name	Direction	Section No.	PSI Value
Road No. 80	From Hilla- Karbala to Mall Qariya	1	3.19
		2	3.00
		3	3.37
		4	3.08
		5	2.89
	From Mall Qariya to Shariefa Intersection	1	2.82
	From Sharifa Intersection to Hilla - Najaf	1	2.72
		2	2.68
		3	2.89
		4	2.89
		5	2.82
		Average	3.00

5. CONCLUSIONS

This study aimed to evaluate the performance of asphalt pavements in Hilla City, specifically focusing on Road No.80, by employing the present serviceability rating and the pavement condition index (PCI) as assessment methods. Various distress types were identified through a comprehensive pavement distress condition rating approach, including longitudinal and transverse cracking, rutting, potholes, patching, and alligator cracking. The findings of this study contribute to the understanding and managing of asphalt pavement distress in the context of Hilla City. The high prevalence of distresses observed on Road No.80 highlights the urgent need for effective road maintenance and rehabilitation strategies. It is evident that the poor execution and design of road layers, low-quality asphalt wearing course, reduced thickness, insufficient compaction, and other factors have contributed to the distresses in the roadways of Hilla City.

The application of the pavement condition index (PCI) and present serviceability index (PSI) provided valuable insights into the overall condition and level of failure of the asphalt pavements. These indices serve as reliable indicators for assessing the operational condition and structural reliability of pavements based on visual assessments of distress type, severity, and quantity. By utilizing these indices, decision-makers can prioritize maintenance and rehabilitation efforts, allocate resources effectively, and ensure the long-term functionality of the road network. To optimize pavement management in Hilla City, it is crucial to develop a robust road maintenance management system. This system should incorporate regular pavement condition surveys to provide essential information for assessing pavement serviceability, estimating maintenance and rehabilitation needs, and prioritizing actions. Implementing effective road maintenance and rehabilitation strategies based on these assessments will contribute to improving the overall quality and longevity of the roadway pavements in Hilla City.

In conclusion, this study emphasizes the significance of accurate pavement condition evaluations and the adoption of appropriate maintenance and rehabilitation strategies. By addressing the identified distresses and implementing proactive measures, Hilla City can enhance the durability, safety, and efficiency of its asphalt pavements, contributing to the overall development and well-being of the transportation infrastructure.

6. RECOMMENDATIONS:

Based on the findings of this study, the following recommendations are proposed to improve the condition and longevity of the road network:

1. Implement Regular Pavement Condition Surveys: It is crucial to establish a systematic and regular pavement condition survey program to monitor the state of the road network. This will provide valuable data for assessing pavement serviceability, identifying distresses, and prioritizing maintenance and rehabilitation activities.

2. Prioritize Preventive Maintenance: Emphasize implementing preventive maintenance strategies to address early distress and prevent further deterioration. This includes timely crack sealing, patching of potholes, and corrective measures to mitigate rutting and edge cracking.

3. Enhance Asphalt Mixture Design: Improve the quality and design of asphalt mixtures used in pavement construction and rehabilitation. This should include selecting appropriate aggregate gradation, binder type, and mix proportions to ensure better resistance to distress and climate-related factors.

4. Strengthen Subgrade and Drainage Systems: Address weak subgrade conditions by implementing proper subgrade stabilization techniques. Additionally, improve the drainage systems to minimize the adverse effects of water infiltration on pavement performance.

5.Develop a Robust Road Maintenance Management System: Establish an efficient road maintenance management system that integrates pavement condition data, maintenance schedules, and resource allocation strategies. This system should prioritize high-traffic areas and roads with significant distress for timely intervention.

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