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icse@bwu.edu.ly

Determining the value of the pavement condition index for some traffic intersections using a Paver program.

Abdelrazag Faraj Emhemed
The Libyan Center for Engineering and Information Technology
*Crossponding author: resqe2010@gmail.com

Abstract: Traffic intersections are considered the most important area in road and traffic networks because increased traffic delay time and accidents are often caused by intersections. There are several factors that affect traffic movement at the intersection, such as the engineering design, which includes the number and width of lanes. The middle island is designed to separate and direct some of the rotational movements at the intersection. Many countries have paid attention to transport networks, improving them and raising their level. In Libya, the transport sector in the city of Bani Walid has witnessed a remarkable development since its inception, as there is a modern network linking the city to other regions. The length of the internal roads until the year 2000 reached about 660 km, while the length of the external roads reached Until the year 2000, about 1,194 km, and the length of the city's agricultural roads reached 754 km, in addition to the internal roads. In order to maintain the condition of the paving with a good level of service. In this study, some traffic intersections within the city were tested and determine the value of the pavement condition Index using the Paver program.
Keywords: Asphalt, Roads, PCI, asphalt condition index

1. Introduction:

Traffic intersections are considered the most important area in road and traffic networks because increased traffic delay time and accidents are often caused by intersections that obstruct traffic or Accidents are caused due to poor design, resulting in traffic congestion, or what is known as a bottleneck. Traffic problems often occur after years of road operation. Most roads in cities have their capacity and travel time determined based on the number and types of traffic intersections. In addition, a large portion of accidents and road safety elements are due to the way the intersection is operated, and the engineering and construction status of the intersection. Here, the planning and design of intersections is the main element in providing safety and efficiency for traffic on the road.

There are several factors that affect traffic movement at the intersection, such as the engineering design, which includes the number of lanes and their width, the design of the middle island to separate and direct some turning movements at the intersection, and technical methods of traffic control such as operating traffic lights and organizing traffic priority. The most important of all of this is the geometric position of the intersection and its extent. Suitability of asphalt.

Many countries have paid attention to transport networks, improving them and raising their level. In Libya, the transport sector in the city of Bani Walid has witnessed a remarkable development since its inception, as there has become a modern network linking the city to other regions. The length of the internal roads until the year 2000 reached about 660 km, while the length of the external roads reached until the year 2000, it was about 1,194 km, and the length of the city's agricultural roads reached 754 km, in addition to internal roads.

In order to maintain the condition of the pavement with a good service level, attention must be paid to managing maintenance work and implementing it in a timely manner. In this study, some traffic intersections within the city were evaluated and the value of the pavement condition was determined using the Paver program.

2. The study Problem:

Some roads are no longer structurally fit due to the near end of their lifespan and the absence of regular maintenance, which has led to the deterioration of the intersections from a structural standpoint, which directly affects traffic at the intersection and the safety of drivers.

3. Methodology:

Field work was carried out, determining the number of samples and the type of defects present in each sample, entering data into the Paver program, and determining the value of the pavement condition Index.

4. Paver 5.2 program:

The Paver program, which determines the value of the pavement modulus, is considered one of the advanced methods for assessing the condition of the pavement and detecting defects in it. It is a program developed by the US Corps of Engineers. This system takes into account the severity, type, and density of the defect present in the pavement in preparation for calculating the pavement modulus, which is a digital scale ranging from 1 to 100. The number 100% indicates the excellent condition of the pavement. The program is used in large areas of the world to periodically inspect roads in preparation for starting maintenance when needed.

4.1 Paver Program Advantages:

1. It includes all possible causes of the appearance of pavement defects.

2. Easy to understand and implement, and simple steps.

3. It is widely used and used to evaluate roads and the condition of airport runways as well.

4.2 How the program works:

Before starting work on the program, we calculate the number of samples to be examined using the equation**:**

$$n = \frac{Ns^2}{\left(\left(\frac{e^2}{4}\right)(N-1) + s^2\right)}$$

Where:

(n): the number of samples to be tested.

(N): the total number of samples.

(s): The constant in the equation is 10 in the case of flexible pavements and 15 in the case of rigid pavements.

(e): acceptable error rate = 5.

(M): number of sample.

(i): The distance between each sample and the next one.

After completing the field study and identifying the defects and samples, the data is entered into the Paver program, and we begin by entering the number of samples and the surface area of each sample, then listing the defects present in each sample separately and determining the percentage of the area of defects from the total area of the sample, and the elastic pavement modulus is calculated, and based on that, the Determine the structural suitability of the road.

The program can calculate the Pavement Condition Index (PCI) based on the severity and density of the following collapses:

Alligator Cracking, Bleeding, Block Cracking

Bumps & Sags, Corrugation, Depression, Edge Cracking, Joint Reflection Cracking, Lane/Shoulder Drop Off, Longitudinal/Transverse, Patch/Utility Cut, Polished Aggregate O, Pothole, Railroad Crossing, Rutting, Shoving, Slippage Cracking Swell, and Weathering/Raveling.

After completing the input process and calculating the Pavement Condition Index, the (PCI) value is dropped on the curve that appears in Figure (1) to know the type and amount of maintenance required.
The figure displays a diagram showing the work methodology for carrying out maintenance and rehabilitation activities for each section of the road, explaining the time period of the pavement's life, as the pavement at its beginning is more effective in performance, and after time passes, maintenance must begin at different degrees depending on the condition of the pavement and the value of the calculated service index.

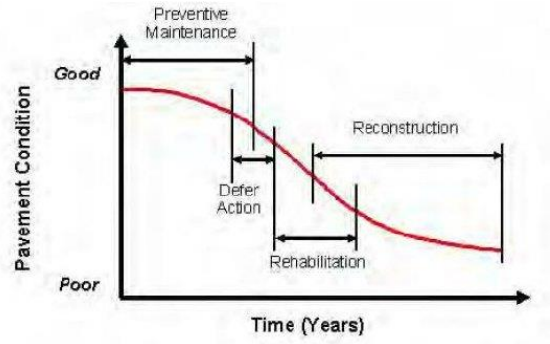

Fig. 1: Pavement condition curve through PCI index (Colorado State University, Paver Pavement Management Software)

5. The Selected intersections

Two intersections were chosen in the city of Bani Walid with different geometric shapes and traffic flow as a result of their distance and proximity to the city center, which are a three-leg intersection and a four-leg intersection.

5.1 First Intersection (Abusedra):

A surface intersection connects traffic between the city center and the northern and southern parts bordering Wadi Bani Walid, where the southern road heads to the city center, the eastern road to Al-Mardoum and from there to Zliten, while the western road heads to the northern part of the city and from there to the road linking Bani Walid and Tarhuna.
A single-level, three-legged, dual-directional intersection with two lanes in each direction, and the direction (north-south) is separated by a central island extending along the road between the intersection and the turning island at its end. Figure (2) shows the intersection.

Fig. 2: Abusedra Intersection

5.1.1 Intersection Geometrical Elements:

Table (1) shows the geometric characteristics of the intersection.

Table 1: the geometric of intersection

Ground marks	Marks	Lane width m	Lane numbers	leg
Good	/	2.7	4	A
Need work	/	3	2	B
Need work	/	2.7	4	C

The process of observing and measuring the severity and density of the defects was carried out after determining the number of samples and the type, severity and density of the defect in each of them, as shown in Table No. (2), in preparation for starting to enter them into the (Paver) program. Figure (3) shows some damages at the intersection.

Fig. 2: Damages in the intersection

Table 2: Samples.

Pavement Distress Type	Sample number									
	1	2	3	4	5	6	7	8	9	10
Alligator Cracking			•							•
Bleeding									•	
Block Cracking						•	•	•		
Bumps & Sags			•							
Corrugation									•	
Depression		•			•					
Edge Cracking										
Joint Reflection Cracking										
Lane/Shoulder Drop Off		•				•				•
Longitudinal /Transverse Cracking										
Patch/Utility Cut										
Polished Aggregate O										
Pothole										•
Railroad Crossing										
Rutting	•	•								
Shoving										•
Slippage Cracking										
Swell				•	•	•				
Weathering /Raveling										

5.1.2 Data entering:

The number of each sample and the percentage of damage from the total area are entered, and sample number appears in Figure (4).

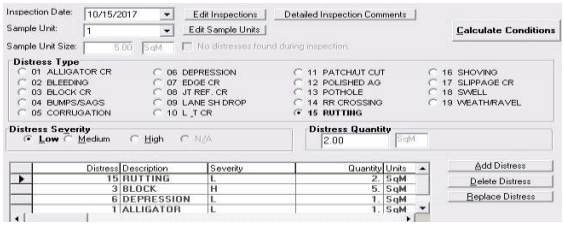

Fig. 3: Samples data entry

After entering all the samples, the program calculates the pavement condition index, as shown in Figure No (5).

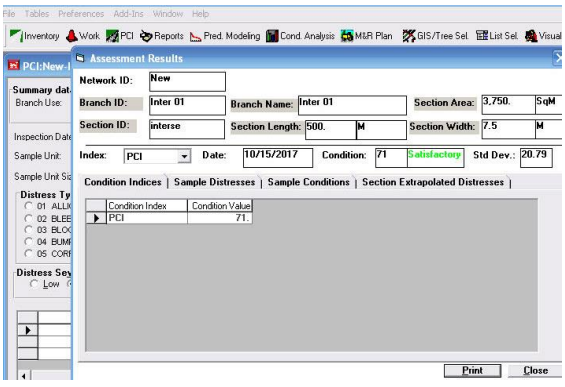

Fig. 4: PCI calculation

71 is the pavement condition indicator at this intersection. By projecting it onto the curve, it becomes clear that the paving is in good condition, as shown in figure (6).

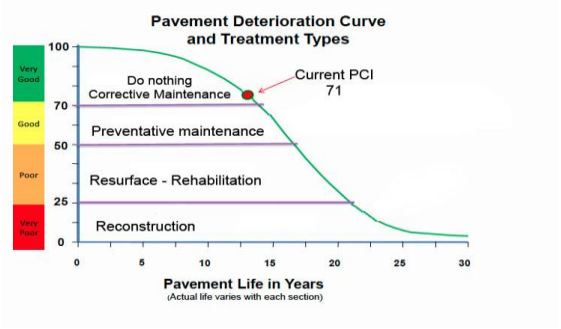

Fig. 5: The location of the current indicator on the PCI curve.

5.2 Second Intersection:

A four-legged surface intersection is located in the center of the city. There are many service and vital facilities on both sides of the road before and after the intersection, such as Sanaa Muhaidli High School, the Teachers College, the School for the Deaf and Hard of Hearing, the clinic complex and public housing, which causes a lot of congestion due to heavy traffic and random parking. On both sides of the road.

5.2.1 Intersection Geometrical Elements:

Table (3) shows the geometric characteristics of the intersection.

Table 3: the geometric of intersection

Ground marks	Marks	Lane width m	Lane numbers	leg
Need work	/	3.6	4	A
/	/	3.6	2	B
/	/	3.6	2	C
/	/	3.6	2	D

Water leaks into the intersection due to cracks in the asphalt surface, which over the past years has caused almost complete damage to the intersection's surface, as rainwater accumulates greatly as a result of the lack of a drainage system inside the intersection and the roads adjacent to it, and the intersection cracks for various reasons, the most important of which may be poor implementation and failure to adhere to the appropriate levels for raising the road body. Figure (6) shows rainwater collecting inside the intersection, which remains for long periods

Fig. 6: The location of the current indicator on the PCI curve.

Figure (7) shows some of the defects in the intersection body and the major damage it has sustained over the past years, as there are many collapses in the paving body, many mesh and alligator cracks, and some potholes and patches as a result of some simple maintenance work in previous years.

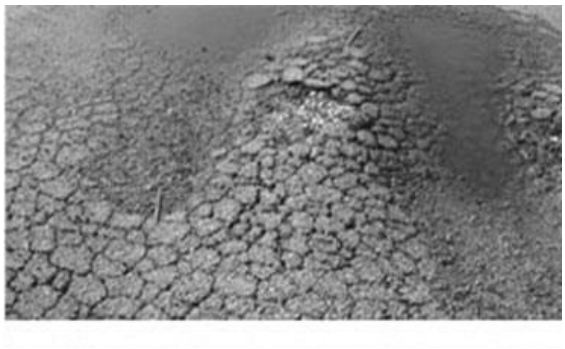

Fig. 7: some of the defects in the intersection body.

By using the same previous steps, the condition of the intersection was very bad, as the asphalt condition indicator was (8), and according to what the location of the indicator appears on the curve in Figure (10), the intersection needs to be reconstructed again.

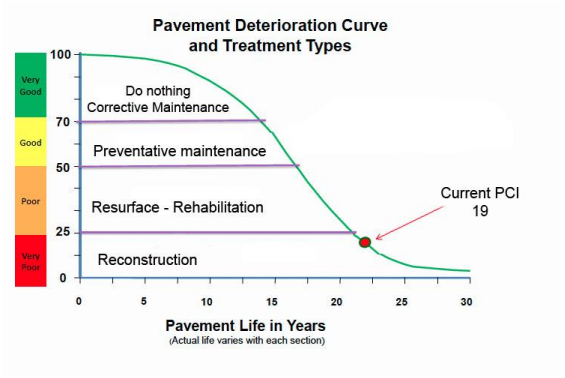

Fig. 10: The location of the current indicator on the PCI curve.

5. Conclusion:

After the field visits and visual inspection, there were some damages in the intersection's pavement layers. The number of samples was determined and the severity and density of the defects and their percentage of the sample area were recorded. The Paver program was used, and after entering the data into the program, it calculated the paving service index and it was 71, which expresses the condition of the area. Good for the intersection surface with the need for some simple maintenance work or what is called (Corrective maintenance).

From a structural standpoint, the second intersection suffers from major problems affecting the traffic movement inside, as rainwater accumulates greatly inside the intersection, which negatively affected the condition of the paving. After studying the constructional condition of the intersection through the (Paver) program, it became clear that the service index is 19, and this indicates that the intersection needs complete rebuilding and maintenance.

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