

Evaluation of Road Condition Using the Pavement Condition Index (PCI) Method in West Ring Road, Kepanjen District, Malang Regency

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Abstract - High traffic on the highway will gradually degrade its quality before it reaches its service life. Pavement deterioration results in damage to the road surface as well as structural damage. Road damage leads to a decrease in the level of traffic safety, comfort and security. Therefore, it is necessary to analyze road damage to determine the appropriate type of handling. The purpose of this study is to describe the level of road damage based on the PCI method on the West Ring Road and determine the type of handling or maintenance from the PCI method on the West Ring Road section. Analysis using the PCI method is carried out based on the Guidelines for Determining the Pavement Condition Index (IKP) Pd 01-2016-B. The data used in this study are primary data obtained through field surveys and secondary data in the form of road section data obtained from the PUPR Office of Malang Regency. From this study, it was obtained that the level of road damage on the West Ring Road section of Kepanjen District from Malang to Blitar using the PCI method was moderate with a PCI value of 56,88. The type of handling or maintenance based on the PCI method is structural improvement.

Keywords - Pavement Condition Index, Road Deterioration, Road Maintenance.

I. INTRODUCTION

The highway is a very important transportation infrastructure for the community to fulfill their daily activities. Roads are also infrastructure in supporting the pace of the economy and play a very large role in the progress and development of an area and are one of the land transportation facilities that are very important in aspects of human activities [1]. Road damage is one of the complex problems that occur in almost every region in Indonesia, not infrequently this road damage occurs before the road life plan ends [2].

According to Badan Pusat Statistik (2020), roads with damaged and severely damaged conditions are 14.98% and 20.47% of the total length of non toll roads or 192,999 Km, respectively. According to district road stability data, there is a steady road condition with a percentage of 54% or 211.644.08 Km in 2019 [4]. Damage that occurs is usually not due to one factor alone, but a combination of interrelated factors [2]. Therefore, negligence of a small damage will cause a much bigger damage.

High traffic on the highway will gradually degrade its quality before reaching its service life [5]. The decline in pavement quality results in damage to the road surface as well as structural damage [6]. Pavement damage is also caused by the load on passing vehicles not in accordance with the carrying capacity of the pavement, the low quality of construction and materials, and road planning and maintenance that does not meet the standards [7].

According to Ray (2013) the condition of roads at the district and provincial levels, which account for 91 percent of the total length of Indonesia's road network, has deteriorated significantly in the past decade. The cause is a combination of inadequate funding for maintenance and poor implementation of funded maintenance

works [9]. Therefore, it is important to analyze and address the condition of existing pavement defects in regions in Indonesia. Road conditions can be evaluated using visual surveys.

Visual survey is the first step to identify the condition of the road surface based on the type and level of damage [10]. One of the visual surveys that can be used is the PCI method. The PCI method can provide more specific road damage analysis results than other methods [11]. This method also has a good pavement management system in determining the existing condition of a road section and in predicting future conditions by conducting periodic classification [12].

This research was conducted on the West Ring Road section of Kepanjen District from Malang to Blitar. Jalibar is a road that connects Malang Regency with Blitar Regency which has a length of 4,560 meters with a total width of 15 meters consisting of 4 lanes in 2 directions [13]. The current condition of Jalibar has a lot of damage such as potholes, cracks, and wavy roads. Motorcyclists and cars are required to be careful in choosing the path to be passed. Because many holes caused by high rainfall cause very severe damage.

It is not uncommon for motorcyclists to have single accidents due to potholes. Therefore, in addition to being careful in choosing the road when crossing this route, motorcyclists should give a minimum distance of 5 meters to the vehicle in front of them. Apart from the high rainfall, this road damage is also caused by heavy vehicles such as buses and trucks that often pass through, making this road even worse damaged [14].

II. MATERIALS AND METHODS

Continuous road use and not accompanied by good maintenance can cause road damage so that it does not match the planned road life [2]. In general, pavement damage is divided into two, namely structural and functional damage [15]. According to Direktorat Jenderal Bina Marga (2021) structural damage is damage where the pavement can no longer bear the traffic load caused by pavement failure, or damage to pavement components. While functional damage is damage that causes disruption of safety and comfort to road users and results in increased vehicle operating costs.

In a study by Mubarak (2016), it is stated that pavement damage is caused by non conformity of work execution procedures to the plan and lack of quality control. In addition, pavement damage can also be caused by the following [18]:

- a. Excessive traffic load;
- b. Poor quality of the materials that make up the pavement layer;
- c. Insufficient compaction of subgrade and pavement layers;
- d. Poor drainage function; and
- e. fatigue in the pavement layer structure

In Study by Udiana (2014) [19], in his research states that the types of flexural pavement damage are classified as follows:

- a. Deformation, which is the change in the shape of the pavement surface from its initial shape.
- b. Cracking, which is damage that occurs when the stress on the surface layer exceeds the allowable stress.
- c. Surface texture damage, which is the gradual loss of materials that make up the flexible pavement construction in the surface layer and can spread to the layers below.
- d. Damage at the edge of the pavement, where the pavement surface meets the shoulder. Damage occurs in the form of cracking that occurs locally or extends along the road. This damage can result in reduced pavement width, water ingress in the foundation layer and erosion of the road shoulder.
- e. Pothole damage, which is damage that occurs due to the loss of wear layer and foundation layer material that causes indentations in the pavement surface. Pothole damage can occur due to poor pavement materials, water ingress into the pavement, disintegration of the foundation layer due to traffic load.

The use of the PCI method is regulated in the Guidelines for Determining the Pavement Condition Index (Pd 01-2016-B). The level of condition of the pavement surface is based on the damage observed during the survey. The types of damage are divided into 19 types of damage which can be seen in Table 1 [20].

Table 1. Types of Road Damage

No	Type of Damage	No	Type of Damage
1	Crocodile Skin Crack	11	Aggregate Wear
2	Overweight	12	Hole
3	Crack Block	13	Railroad Crossing
4	Tufts and Curves	14	Flow
5	Curly	15	Sungkur
6	Slump/Depression	16	Skid Cracks
7	Edge Crack	17	Expansion
8	Lane/Boulder Drop	18	Grain Release
9	Longitudinal/Transverse Cracks	19	Weathering
10	Patches		

Source: *Pavement Condition Index Determination Guidelines (2016)*

In analyzing road damage using the PCI method, there are four stages of calculation, namely 1) calculation of damage density, 2) determination of deduct value, 3) determination of maximum corrected deduct value, and 4) calculation of PCI value using Equation (1) [21].

$$PCI = 100 - CDV_{maks} \quad (1)$$

Description:

PCI : Average PCI value of sample units in one road section

CDV_{maks} : Maximum corrected subtraction value of the sample unit

Meanwhile, the PCI value of the segment as a whole is calculated using Equation (2).

$$PCI_{ruas} = \frac{\sum PCI_s}{n} \quad (2)$$

Description:

PCI_{segment} : PCI value in one road section

$\sum PCI_s$: Average PCI value of sample units in one road section

n : Number of sample units surveyed

The PCI value obtained is then used to determine the level of road damage as shown in Table 2. In addition, the PCI value is also used to determine the type of treatment needed with the range of values in Table 3.

Table 2. PCI Value Scale and Conditions

No	Damage Condition	PCI Value
1	Good	85 – 100
2	Satisfactory	70 – 85
3	Fair	55 – 70
4	Poor	40 – 55
5	Very Poor	25 – 40
6	Serious	10 – 25
7	Failed	0 – 10

Source: *Pavement Condition Index Determination Guidelines (2016)*

Table 3. PCI Value and Treatment Type

No	PCI Value	Type of Handling
1	> 85	Routine Maintenance
2	70 – 85	Periodic Maintenance
3	55 – 70	Structural Upgrades
4	< 55	Reconstruction/Recycling

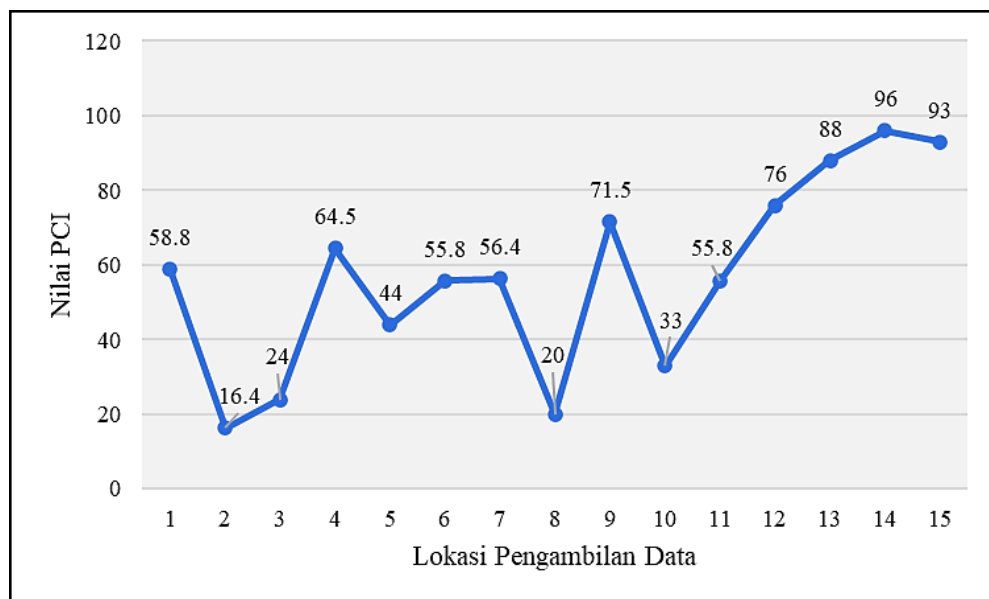
Source: Pavement Condition Index Determination Guidelines (2016)

III. RESULTS AND DISCUSSION

From the analysis using the PCI method, the resulting level of road damage in each sample unit and damage to the study location numerically in the form of PCI values. A recapitulation of the PCI value for each sample unit on the West Ring Road of Kepanjen Subdistrict from Malang to Blitar can be seen in Table 4 and Figure 1.

Table 4. Recapitulation of PCI Value for each Sample Unit

Sample	STA	PCI Value	Class Condition
1	0+200 - 0+300	58,8	Fair
2	0+500 - 0+600	16,4	Serious
3	0+800 - 0+900	24	Serious
4	1+100 - 1+200	64,5	Fair
5	1+400 - 1+500	44	Poor
6	1+700 - 1+800	55,8	Fair
7	2+000 - 2+100	56,4	Fair
8	2+300 - 2+400	20	Serious
9	2+600 - 2+700	71,5	Satisfactory
10	2+900 - 3+000	33	Very Poor
11	3+200 - 3+300	55,8	Fair
12	3+500 - 3+600	76	Satisfactory
13	3+800 - 3+900	88	Good
14	4+100 - 4+200	96	Good
15	4+400 - 4+500	93	Good

**Figure 1. Road Damage Chart**

The lowest PCI value on the West Ring Road section is at STA 0+500 – 0+600 which is 16.4 with a serious condition class, while the highest PCI value is at STA 4+100 – 4+200 which is 96 with a good condition class. From the average PCI value of all sample units, the PCI value of the West Ring Road section of Kepanjen District is 56,88 with road damage that is often found in each sample unit including crocodile skin cracks, block cracks, collapse/depression, edge cracks, holes, patches, and grain release. From this value, the West Ring Road section of Kepanjen Subdistrict from Malang to Blitar is categorized as having a moderate level of damage. In the PCI method, the determination of the type of handling must be adjusted to the severity of the road damage that occurs. The type of treatment required can be seen in Table 5.

Table 5. PCi Value and Type of Handling

Sample Number	STA	PCI Value	Class Condition	Type of Handling
1	0+200 - 0+300	58,8	Fair	Structural Upgrades
2	0+500 - 0+600	16,4	Serious	Reconstruction/Recycling
3	0+800 - 0+900	24	Serious	Reconstruction/Recycling
4	1+100 - 1+200	64,5	Fair	Structural Upgrades
5	1+400 - 1+500	44	Poor	Reconstruction/Recycling
6	1+700 - 1+800	55,8	Fair	Structural Upgrades
7	2+000 - 2+100	56,4	Fair	Structural Upgrades
8	2+300 - 2+400	20	Serious	Reconstruction/Recycling
9	2+600 - 2+700	71,5	Satisfactory	Periodic Maintenance
10	2+900 - 3+000	33	Very Poor	Reconstruction/Recycling
11	3+200 - 3+300	55,8	Fair	Structural Upgrades
12	3+500 - 3+600	76	Satisfactory	Periodic Maintenance
13	3+800 - 3+900	88	Good	Routine Maintenance
14	4+100 - 4+200	96	Good	Routine Maintenance
15	4+400 - 4+500	93	Good	Routine Maintenance
Section		56,88	Fair	Structural Upgrades

IV. CONCLUSION AND RECOMMENDATIONS

The PCI value serves as a numerical indicator that shows the level of road surface condition and is used as an objective and rational basis for determining road maintenance and repair programs [21]. The results of the road damage analysis using the PCI method on the West Ring Road section of Kepanjen Subdistrict from Malang to Blitar produce different levels of road damage in each sample unit. As presented in Table 3, road damage in each sample unit based on the level of condition on the West Ring Road is in the range of very severe to very good condition classes. From a total of 15 sample units, the percentage of sample units with serious condition classes is 20%, very poor is 6,7%, poor is 6,7%, fair is 33.3%, satisfactory is 13.3%, and good is 20%. The lowest PCI value on the West Ring Road section is at STA 0+500 – 0+600 which is 16.4 with a serious condition class, while the highest PCI value is at STA 4 + 100 - 4 + 200 which is 96 with a good condition class.

From the average PCI value of all sample units, the PCI value of the West Ring Road section is 56,88, there is road damage often found in each sample unit including alligator skin cracks, block cracks, collapse/depression, edge cracks, holes, patches, and grain release. From this value, the West Ring Road section of Kepanjen Subdistrict from Malang to Blitar is categorized as having a fair level of damage. In the study by Ramli dkk. (2018) there were five dominant types of damage, including alligator cracking, edge cracking, block cracking, patching, and particle detachment. Similar findings were reported in the study by Chasanah & Wijaya (2016), which identified several dominant types of damage, including alligator cracking, block cracking, potholes, patching, and subsidence/depression. According to Kementerian Pekerjaan Umum dan Perumahan Rakyat (2016) the types of damage commonly found in the aforementioned studies are caused by various factors,

including soil conditions, natural factors, traffic activity, and the impact of improper pavement construction processes. The recommended treatment based on a PCI value of 56,88 is Structural Upgrades.

Based on the findings of this study, the West Ring Road section requires structural upgrades since the average PCI value of 56.88 falls within the fair category. Sections with serious and very poor condition, such as at STA 0+500 – 0+600 with a PCI value of 16.4, should be prioritized for rehabilitation to prevent further deterioration and reduce future maintenance costs. Meanwhile, road sections classified as satisfactory to good conditions should be maintained through preventive measures, such as crack sealing, surface treatment, and routine inspections, to extend their service life. Considering that the dominant types of damage such as alligator cracking, block cracking, edge cracking, potholes, patching, and depressions are influenced by soil conditions, traffic loads, natural factors, and construction practices, improvements to drainage systems and strict quality control during construction are highly recommended. Furthermore, it is important to establish a long-term pavement management plan that includes periodic PCI-based assessments to support sustainable road maintenance and ensure the optimal performance of the West Ring Road.

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