Pavement Condition Index (PCI) Method for Road Damage Analysis

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ABSTRACT
Roads are economic supporting infrastructure that must be developed and maintained so that the movement of goods and people is smooth and will improve the community's economy. Road damage greatly affects economic growth, road damage is caused by high traffic growth so that it exceeds road capacity and vehicle loads that exceed capacity. Damage to this road, among others, polished aggregate, stripping, corrugation, photoles, bleeding or flushing. The purpose of this research was to find out what types of road damage and the value of the condition of the existing pavement on Kaliurang Street KM 14, Yogyakarta using the Pavement Condition Index (PCI) method. The Pavement Condition Index (PCI) method will determine the category of road damage. This study takes data from the field by measuring damage and taking damage documentation to determine the type of damage. Based on the research that has been done, the results of the analysis show that there are six (6) types of road damage that occurred on Kaliurang Street KM 14, Yogyakarta, among others, Crocodile skin cracks, longitudinal/transverse cracks, Grain release, Patches, Block cracks, and Holes. With an average PCI value of 32.4, the condition of the pavement on Kaliurang Street KM 14 is categorized as Poor.

***Keywords**: infrastructure, Road, Damage, Pavement Condition index (PCI),*

1. INTRODUCTION

In accordance with the Law of the Republic of Indonesia No. 38 of 2004 concerning road infrastructure, states that roads have an important role in realizing the development of the nation's life. So the road is needed by the community in carrying out daily activities, so that a road plan is expected to fulfill the basic function of the road.

According to Sukirman [1] damage to road pavement construction can be caused by increased traffic, water due to poor drainage, poor material, a climate where air temperature and rainfall are high, unstable soil and poor soil compaction. The damage was caused by various factors including high traffic volume and the burden of passing vehicles. Road damage will affect the safety and comfort of road users which may cause accidents, congestion and others.

Based on the Directorate General of Highways in the Road Maintenance manual No.03/T/MN/B/1983, the types of damage are as follows: Alligator Cracking, Longitudinal/Transverse Cracking, Slippage Cracks, Joint Reflective Cracks, Block Cracking, Meandering, diagonal cracks and damage to the edges of the pavement.

The Kaliurang road section is an arterial and collector road, which is located in the district of Sleman, Yogyakarta. This road leads to tourism objects on Mount Merapi, campuses, hospitals as well as economic and government activities, besides that this road is very important because it is an evacuation route when the eruption of Mount Merapi occurs.

Jalan Kaliurang has a length of approximately 25 km, because this road is very important for traffic flow, it is necessary to conduct research to determine the condition of the road. This research was conducted not in all sections, but took the road at KM 14 along 1000 m, with a road width of 8.4 m.

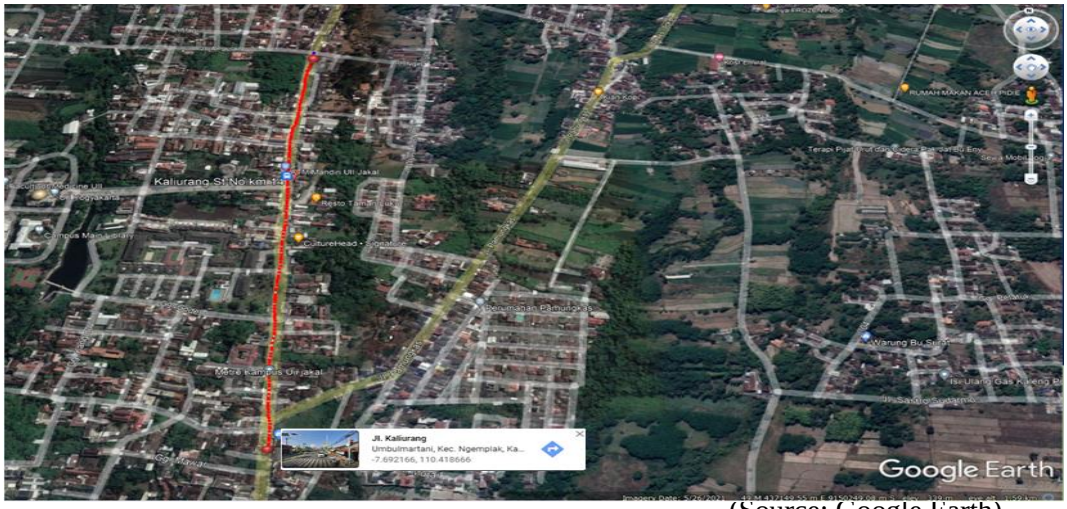
The method used in this study is the PCI method, where this method can be used as a reference for road pavement maintenance and road damage handling by providing information about the condition of the pavement.

Pavement Condition Index (PCI) is an estimate of road conditions with a rating system to state the actual pavement condition with reliable and objective data. PCI is a numeric index whose values range from 0 which indicates a very damaged condition to 100 which indicates that the pavement is still perfect.

According to Shahin [2], the condition of the pavement is divided into several levels, namely: Excellent if the PCI score reaches 85-100, Very Good if the PCI score reaches 70-85, Good if the PCI score reaches 55-70, Fair if the PCI score reaches 40- 55, Poor if the PCI score reaches 25-40, Very Poor if the PCI score reaches 10-25, Failed if the PCI score is 0-10.

2. METHODS

The research location for road damage is on Jalan Kaliurang KM.14, Sukoharjo, Ngaglik, Umbulmartani, Ngemplak District, Sleman Regency, Yogyakarta Special Region. By Classification the road is a district road (primary collector) has a road type that is 2/2 UD (Undivide), Width 8.4 m long with the length of the road under review is 1000 m. The research location can be seen in Figure 1.



(Source: Google Earth)

Figure 1. The research location

This primary data collection was obtained by direct observation and then measured and analyzed recorded on the prepared sheet/form with the aim of storing the information obtained, in the form of: direct photos/documentation during the survey and data on the condition of road damage on Jalan Kaliurang KM 14-15. For secondary data, in the form of references and information from agencies or institutions and researchers previous studies related to research, such as pictures of research locations obtained from Google Earth.

Calculation With PCI Method

1. Finding the percentage of damage area / Density Density is the percentage area of the total length of a type of damage or the total length of the road segment that has been measured. Therefore, the breakdown density is expressed in the following Equation.

   $$(density)(\%) = \frac{\text{Ad}}{\text{As}} x100$$

   Or,

   $$(density)(\%) = \frac{\text{Ld}}{\text{As}} x100$$

Where :
Ad= Total area of damage type for each damage (m^2)
Ld = Total length of damage type for each level of damage (m)
As = Total area of segment (m^2)

2. Determine the Deduct Value
   After getting the density value, each type of damage is plotted on the damage level graph to obtain the deduct value.
3. Add up the Total Deduct Value
   To calculate the total value of the reduction (TDV), which has been obtained from the part of the road that has been observed and then added up, the total value of the deduct value is obtained.
4. Finding the value of q

   Determine the value of q such that the value of q is determined by the sum of the individual deduct values greater than 2 per iteration. The deduct values are sorted from largest to smallest. Check the deduct value with the equation below.

   Mi = 1 (9/98)(100-HDVi)

   Where :
   Mi = Correction value for subtraction value
   HDVi = Distributed value of penalty value in sample units
   If all the DV values are greater than the Dv values, the DV values are subtracted from the Mi values, but if the DV values are less than Mi, there is no need to subtract the subtraction values.
5. Finding the CDV (Corrected Deduct Value)
   The CDV value can be found after the q value is obtained by adding up the deduction values and then plotting the total DV value based on the q value on the CDV graph. The CDV value is obtained from the correlation curve between the total value (TDV) and the value (DV) with the appropriate curve. If the obtained CDV value is less than the highest deduction value (HDV), then the CDV used is the highest individual deduction value.
6. Determine the PCI (Pavement Condition Index) Value
   After obtaining the CDV value, the PCI value can be determined using the equation below.

   PCI = 100-CDV

   Once the PCI value is known, the score can be determined from the sample unit under review by entering it into a graph. To calculate the total PCI value on a road segment, it can be calculated using the equation below.

$$\boldsymbol{PCI} = \frac{\sum \mathbf{PCI}\ (\mathbf{s})}{\boldsymbol{N}}$$

Where :
PCI = Road segment pavement condition index
CDV =Fix road segment penalty value.
N =Number of detected sample units

3. RESULTS AND DISCUSSION

The data collected which includes the length of damage, width of damage and distance/depth of damage is entered into the record table of road damage conditions. The data is then analyzed to determine the value and level of road damage using the Pavement Condition Index (PCI) method.

After knowing the dimensions of each type of damage in the field, then the dimensions of the damage in the form of area and length then calculate the density value.

To determine the DV value, enter the density value of each type into the curve as shown in Figure 2.

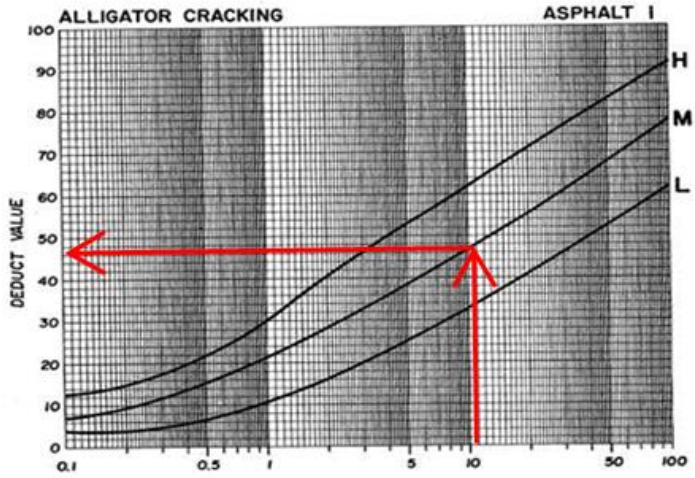


Figure 2. Deduct Value in segment 5
(STA 14+200 – 14+250)

Figure 2. shows that the Deduct Value for Alligator Cracking is 47, which is determined from the density value for Crocodile Skin Crack damage, which is 11.16% with a moderate level of damage (M). The density values and DV values are calculated as shown in Table 1.

Table 1. Density and DV Values

STA/KM	Type	Quantity			Total	*Density* (%)	DV value
14+200 - 14+250	1M	5.39	18.11	23.37	46.9	11.16	47
	11M	17.25	-	-	17.3	4.11	19
	10H	4.8	0.53	1.29	15.4	3.65	37
	13M	0.0272	0.316	-	0.6	0.14	40
	19H	17.59	-	-	17.6	4.19	27
	3M	19.13	-	-	19.1	4.55	9

Calculations to determine the total subtraction value (TDV), q value are in Table 2.

Table 2. Determination of TDV and q value

NO	STA	11. Patching			13. Potholes			Total Deduct Value (TDV)	q
		10. Longitudinal /Transverse Cracking			19.Weathering and Graveling				
		1.Alligator Cracking			3. Block Cracking				
		11	10	1	13	19	3		
1	14+000 – 14+050	37	36	68				141	3
2	14+050 -14+100				30	71		101	2

3	14+100 – 14+150	10	25	43				78	3
4	14+150 – 14+200	9		67	27		3	106	4
5	14+200 – 14+250	19	37	47	40	27	9	179	6
Continuation of Table 2									
6	14+250 – 14+300	27	50	59		10	31	177	5
7	14+300 – 14+350	39	34		28		43	144	4
8	14+350 – 14+ 400	44		62				106	2
9	14+400 – 14+450	21	47				6	74	3
10	14+450 – 14+500	26		32			8	66	3
11	14+500 – 14+550	41	11	58				110	3
12	14+550 – 14+600	11	53	40			8	112	4
13	14+600 – 14+650	20	12	50				82	3
14	14+650 – 14+700	2		47	68		35	152	3
15	14+700 – 14+750	7		23	17	9		56	4
16	14+750 – 14+800	3		77	72			152	3
17	14+800 -14+850	4		31			13	48	3
18	14+850-14+900	32		59		26	9	126	4
19	14+900 – 14+950	35		56		33	27	151	4
20	14+950 – 15+000	42	13	55			19	129	4

Corrected Deduct Value (CDV) is obtained by using a graph of the relationship between the total value of subtraction (TDV) and the value of q as shown in Figure 3.

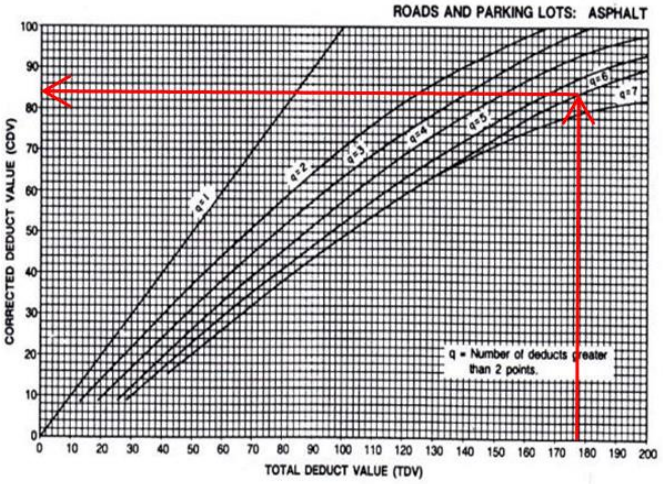


Figure 3. Corrected Deduct Value in segment 5
(STA 14+200 – 14+250)

To get the value of the pavement condition for the PCI method, a calculation is carried out to determine the PCI value in segment 5.

PCIs = 100 – CDV
= 100 – 84
= 16

The value of the pavement condition for the PCI method in segment 5 is 16, this value if you see Figure 2 regarding the values and conditions based on the PCI method, then segment 5 with a PCI value of 16 is in the Very Poor category. For the calculation of all segments can be seen in Table 3.

Table 3. Recapitulation of PCI Values per Segment

Segmen	STA	CDV	PCI Value	Pavement Condition
1	14+000 - 14+050	84	16	Very Poor
2	14+050 -14+100	71	29	Poor
3	14+100 - 14+150	50	50	Fair
4	14+150 - 14+200	67	33	Poor
5	14+200 - 14+250	84	16	Very Poor
6	14+250 - 14+300	92	8	Failed
7	14+300 - 14+350	86	14	Very Poor
8	14+350 - 14+ 400	75	25	Very Poor
9	14+400 - 14+450	47	53	Fair
10	14+450 - 14+500	42	58	Good
11	14+500 - 14+550	69	31	Poor
12	14+550 - 14+600	66	34	Poor
13	14+600 - 14+650	52	48	Fair
14	14+650 - 14+700	89	11	Very Poor
15	14+700 - 14+750	30	70	Good
16	14+750 - 14+800	87	13	Very Poor
17	14+800 -14+850	30	70	Good
18	14+850-14+900	72	28	Poor
19	14+900 - 14+950	83	17	Very Poor
20	14+950 - 15+000	73	27	Poor
TOTAL		1349	651	Poor
PCI Average			32.55	

From Table 3. the average PCI value on Jalan Kaliurang Kilometer 14, STA 14+000 – 15+000 is 32.55, so the value of the pavement condition is categorized as POOR.

4. CONCLUSION

There are 6 (six) types of road damage that occurred on Jalan Kaliurang Km 14 Yogyakarta, including Alligator Cracking, Longitudinal/Transverse Cracking, Weathering and Graveling, Patching,

Block Cracking and Potholes. PCI average value of 32.55 which indicates the condition of the pavement is categorized as Poor.

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