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Prediction of Remaining Service Life of the Yogyakarta-Kaliurang Provincial Road Section of Sleman Regency using the PCI Method

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ABSTRACT

Roads, as part of the national transportation system, play a crucial role, especially in supporting economic, social, cultural, and environmental aspects. They are developed through regional development approaches to shape the spatial structure to achieve national development goals. One commonly employed method for assessing road damage is the Pavement Condition Index (PCI). This research aims to predict the remaining service life of the Yogyakarta-Kaliurang Road based on the PCI analysis. This study was based on road damage survey data. The visual observation revealed various types of damage, such as alligator cracking, bleeding, block cracking, bumps and sags, corrugation, depression, edge cracking, lane or shoulder drop-off, longitudinal and transverse cracking, patching and utility cut patching, polished aggregate, potholes, rutting, shoving, slippage cracking, swell, weathering, and ravelling. The PCI analysis generated an average value of 59.4%, falling within the fair pavement condition. The highest pavement index was recorded from STA 15+000 to STA 15+100, with a score of 100%, signifying a good condition. In comparison, the lowest pavement index was discovered from STA 19+050 to STA 19+100, with a score of 12%, indicating a serious condition. The analysis of remaining pavement life yielded an average remaining life between 1 to 5 years.

1. Introduction

Roads are infrastructure playing an essential role in supporting safety and smooth traffic flow. Therefore, damage to part of the roads will significantly impact traffic flow. Assessment of the condition of each road must be carried out periodically, both structured and unstructured. Efforts are required to maintain the quality of road services, allowing the roads to accommodate the needs and movements of their users with a certain level of service. Accordingly, analysing road damage can determine the causes of the damage [1]. Road conditions with heavy and repetitive traffic can affect the quality of the road surface, causing discomfort and danger for users. The expected lifespan of a road pavement is not always congruent with its actual lifespan.

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In most cases, road pavements experienced a significant decline in quality before their service life ended [2]. Roads, as part of the national transportation system, play a key role, especially in supporting the economic, social, cultural and environmental fields. They are developed through a regional development approach to achieve balance and equitable development between regions, form and strengthen national unity to bolster national defence and security, and establish a spatial structure to realize national development goals [3]. Apart from being a vehicle mode, roads are also useful for supporting access to natural disaster evacuation [4].

The rapid increase in economic demand and community mobility has resulted in significant consequences for the government. In facing this situation, infrastructure post-construction policies are becoming increasingly crucial. It is due to the various obstacles that arise in the maintenance, rehabilitation and management of existing road networks to keep them functioning properly [5]. Therefore, efforts are highly required to recognize existing damage, quantitatively assess road conditions, and then schedule and prioritize the repair [6]. Road maintenance efforts aim to restore road conditions to make them function properly, either functionally or structurally. Therefore, road handling must be adjusted to the type of damage. Inappropriate handling will only waste the budget spent because the results will not be optimal and the road is likely to be damaged again quickly [7]. The Life Cycle Costing (LCC) approach evaluates the costs associated with the entire lifecycle of the road, including construction, maintenance and end-of-life disposal. This ensures that the service life of the road is considered to minimize costs and maximize durability [8].

Under the Decree of the Head of the Governor of the Special Region of Yogyakarta Number 118/KEP/2016 concerning Determining the Status of Provincial Road Sections, Kaliurang-Yogyakarta Road is a provincial road, with a length of 26,090 km. The road section reviewed in this study was flexible pavement kilometres 14 to 20 [9]. Visual preliminary observation uncovered several types of road damage on the road section, with a variety of damage levels ranging from minor to moderate to severe, in accordance with the existing road damage classification. Alligator cracking and potholes were only some of the road damage types discovered.

A recent study applied artificial intelligence, specifically the YOLO V5 deep neural network algorithm, for real-time pavement crack detection. Using advanced image processing and a custom dataset, the research achieved high accuracy in identifying pavement damages, including longitudinal and transversal cracks, covering areas of 1.1682 m² and 1.9627 m², respectively. This AI-driven approach improves road monitoring, reduces maintenance costs, and highlights the potential of technology in optimizing infrastructure management [10]. The road condition values were employed as a reference to determine the type of treatment, whether it is an improvement program, periodic maintenance, or routine maintenance. Moreover, these alternative treatments could be utilized to determine the costs that must be incurred based on handling conditions on the road [11].

Based on several road treatments with visual road surface condition values, this research utilized the Pavement Condition Index (PCI). The PCI is an assessment system for road pavement conditions based on the type, level, and extent of damage. It could recommend efforts to repair and maintain road damage [12].

The PCI serves as a guideline to determine the pavement conditions based on the type, level, and extent of damage and maintenance required. This research was conducted directly and visually on the Kauditan Road (bypass), with a road section length of 3 km divided into 60 segments, with a segment size of 50 × 6 m [13].

Similar research has been conducted on the 2 km Cibaliung-Sumur Highway Section, with the aim of identifying the value of road cramps and how to handle them. It employed the PCI, generating a value of 20, implying a serious condition [14]. The PCI analysis of the East Kudus Ring Road-Pati Regency unveiled a low remaining service life. Segment 2 had a PCI of 31.14, depicting its very poor condition, with a remaining service life of 0.25 years. Hence, this road section must be immediately repaired [15].

2. Methodology

2.1 Research Location

This research was conducted on Kaliurang Road, Sleman Regency, Yogyakarta Special Region Province, with an observation length of 6 km and a division of 50 m for each segment, totalling 120 segments. The observation began from segment 1, STA 14+00, located at Kaliurang Road Km 14, Sukoharjo, Ngaglik District, Sleman Regency, Yogyakarta Special Region. It ended in segment 120, STA 20+000, located at Kaliurang Road Km 20, Hargobinangun, Pakem District, Sleman Regency, Yogyakarta Special Region. Figure 1 portrays the visual location of the road under study.

Fig. 1. Location of Yogyakarta-Kaliurang Road section (Google Maps, 2023)

2.2 Survey Preparation

The survey was conducted during off-peak hours when there were fewer vehicles on the road, making it easier to conduct research precisely and measurably. Primary data were collected through direct observation at the research location. This study utilized the following tools for sampling survey data:

i. Roll meter, it measured the dimensions of road damage in each segment.
ii. Measuring wheels, it measured the length of the road section under study.
iii. Camera, it documented every research activity at the survey location.
iv. Spray paint, it marked measurement boundaries in each road segment.

2.3 Road Condition Survey

The following steps were taken to collect data in the field:

i. The road survey was conducted by visually observing the types of damage in each segment using one form for each segment.

ii. The Yogyakarta–Kaliurang Road observed was 6 km long and was divided into 120 segments, with each segment spaced 50 m apart.
iii. The survey involved measuring the dimensions of the damage and recording them on the survey form. Measurements were taken using a tape measure. In each segment, the type of damage, extent of damage, and severity were observed.

2.4 Division of Sample Units

In the research sample units, the PCI for each segment on the Yogyakarta-Kaliurang Road was divided into 50 m. The total length of the observed road was 6,000 m. The segment division can be seen as follows:

i. Road width = 7 m
ii. Total road area = 6,000 x 7 = 42,000 m^2
iii. Sample unit area = 50 x 7 = 350 m^2
iv. Number of sample units = 42,000/350 = 120

2.5 Data Analysis

The survey method of PCI refers to ASTM D6433 (Standard Practice for Road and Parking Lot Pavement Condition Surveys). PCI is a system of assessing pavement conditions based on the type, level, and extent of damage. It serves as a reference in maintenance efforts [16]. The PCI value has a range of 0 to 100, with criteria of excellent, very good, good, fair, poor, very poor and failed.

The total level of distress severity is the total amount of each type of damage at each level of severity (low, moderate and high), with the quantity in meters or square meters, depending on the type of damage obtained and then totalled. The density calculation refers to the total amount of each type of distress at each severity level, with the total area of the sample unit multiplied by 100 to obtain the percentage density of each type and level using Eq. (1):

$$\text{Density} = \frac{As}{Ad}\ x\ 100 \tag{1}$$

Description:
Ad = total dimension area of damage type at each damage level (m^2)
As = total unit segment area (m^2)

Deduct value (DV), according to the translated literature, states the current condition of the pavement, i.e., the total amount of damage encountered [17]. The value of each damage segment was followed by the determination of the DV, determined from the DV curve for each type and severity of distress [18]. Each type of damage had a curve or graph to determine the DV by connecting the distress severity results obtained in the field. Figure 2 displays an example of a DV graph.

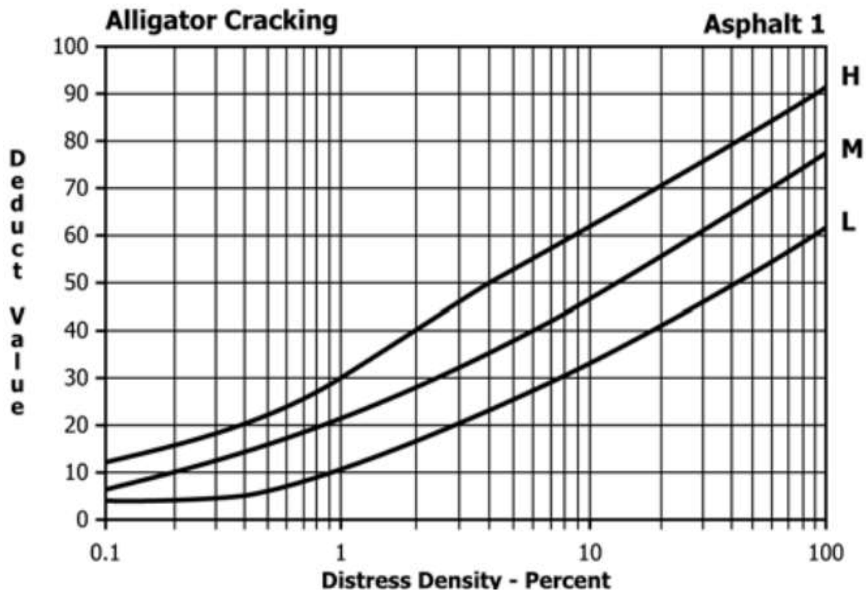


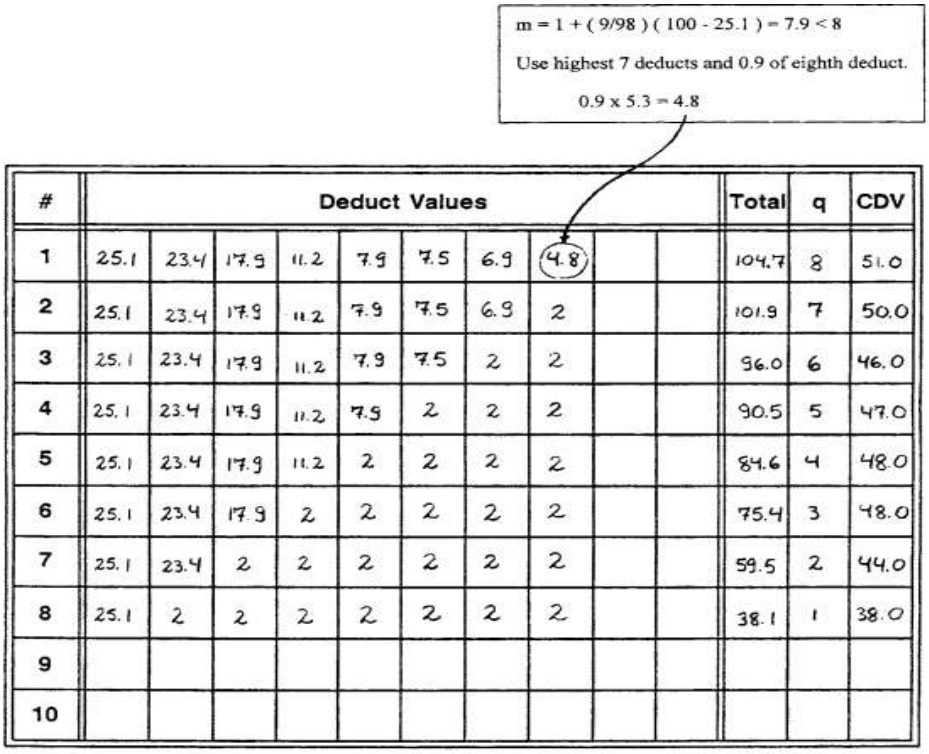
Fig. 2. Deduct value graph of alligator cracking [20]

The total deduct value (TDV) is the total value of each DV at each level and the type of damage obtained in the sample unit along the sample area. The deduction value took into account the maximum DV, which would ultimately affect the q value. The maximum DV was calculated using Eq. (2):

$$M_i = 1 + \left(\frac{9}{98}\right) x\ (100 - HDV_i) \tag{2}$$

Description:
M_i : Allowable number of deducts, including fractions
HDVi : Highest individual deduct value

From Eq. (2), the value of m was obtained and employed as the minimum limit of the DV or the value of the sequence after it must be multiplied by 0.9. Subsequently, the q value as the number of deductions, with a value not replaced by a value of 2, was determined. The smallest individual deduction value greater than 2 was subtracted until q = 1. Figure 3 exhibits the details.



m = 1 + (9/98) (100 - 25.1) = 7.9 < 8
Use highest 7 deducts and 0.9 of eighth deduct.
0.9 x 5.3 = 4.8

#	Deduct Values										Total	q	CDV
1	25.1	23.4	17.9	11.2	7.9	7.5	6.9	4.8			104.7	8	51.0
2	25.1	23.4	17.9	11.2	7.9	7.5	6.9	2			101.9	7	50.0
3	25.1	23.4	17.9	11.2	7.9	7.5	2	2			96.0	6	46.0
4	25.1	23.4	17.9	11.2	7.9	2	2	2			90.5	5	47.0
5	25.1	23.4	17.9	11.2	2	2	2	2			84.6	4	48.0
6	25.1	23.4	17.9	2	2	2	2	2			75.4	3	48.0
7	25.1	23.4	2	2	2	2	2	2			59.5	2	44.0
8	25.1	2	2	2	2	2	2	2			38.1	1	38.0
9													
10													

Fig. 3. Calculation of corrected PCI value—flexible pavement [20]

The corrected deduct value (CDV) was obtained from the relationship curve between the CDV and TDV. The curve line was determined based on the number of individual DVs with a value greater than 2 or the number of q in each DV column [19]. Figure 4 illustrates the curve.

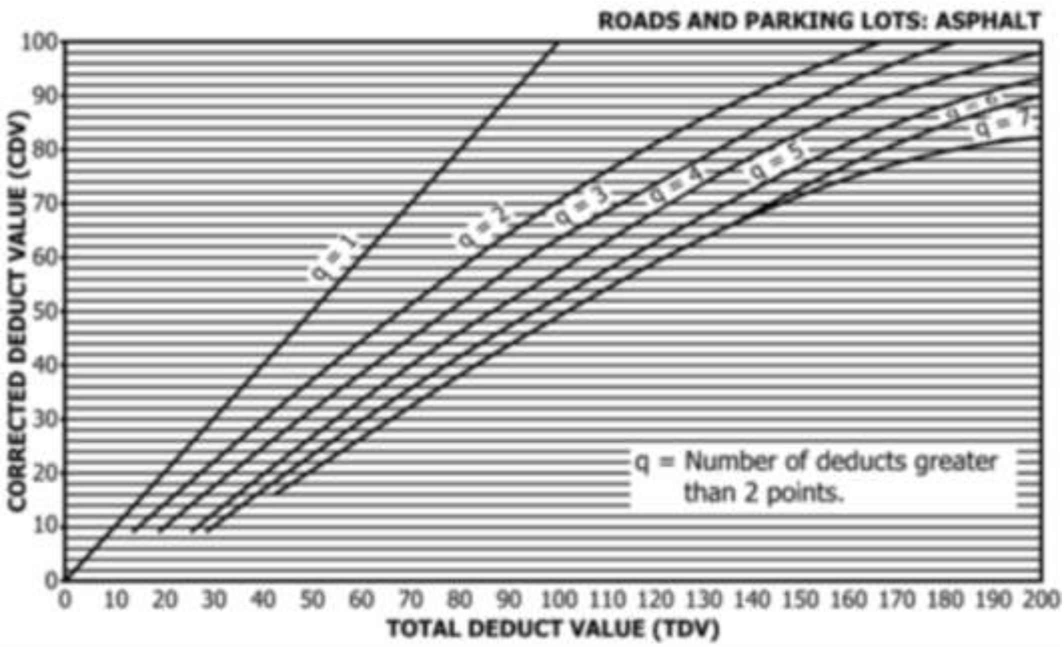


Fig. 4. CDV and TDV relationship graph [2]

After obtaining the CDV, the PCI was determined with the maximum CDV based on ASTM D6433 [20]. The equations can be seen in Eq. (3) and Eq. (4).

$$PCI = 100 - CDV \tag{3}$$

$$PCI = \sum \frac{PCI_S}{N} \tag{4}$$

Description:
PCI = PCI for one sample area or one road segment
PCIs = PCI for each sample unit or segment
N = Number of sample units on the road segment
CDV = Value obtained from the relationship graph of CDV and TDV

PCI is a numerical indicator for evaluating the condition of pavement surfaces. This indicator is divided into seven rating scales [21], as displayed in Figure 5.

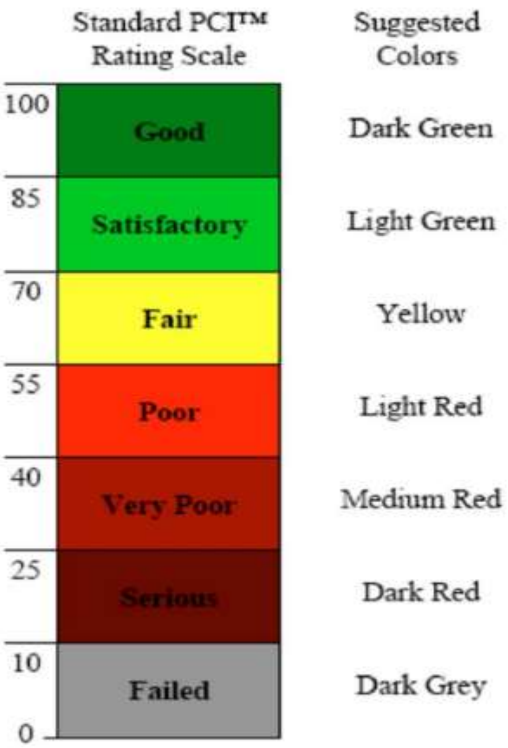


Fig. 5. PCI, rating scale and suggested colours [20]

Table 1 exhibits the PCI decision matrix converted to the remaining service life. As described in Table 1, if the current road is not reconstructed or repaired, the functional level of service will deteriorate and may cause structural damage. Simultaneously, driver factors can impair rider comfort, which is related to safety [22].

Table 1
PCI decision matrix converted to remaining useful life

Tol	Artery Road	Collector Road	Local Road	Remaining Useful Life
>85	>85	>80	>80	11-20 years
85-76	85-76	80-71	80-66	6-10 years
75-66	75-56	70-51	65-46	1-5 years
65-60	55-50	50-45	45-40	0.5-0.9 years
<60	<50	<45	<40	0-0.4 years

The remaining road life was determined using the PCI. The PCI results were classified based on the repair time according to the time of improvement table and converted into years. In the time of improvement table, the criteria for the age of flexible pavement plans were determined based on the 2017 Revised Pavement Design Manual [13].

3. Results and Discussion

3.1 Percentage Deterioration Rate (Density)

On the Yogyakarta-Kaliurang Provincial Road, particularly in segment 102 (STA 19+050 to STA 19+100), the following types of damage were obtained: alligator cracking low, moderate bleeding cracking, moderate block cracking, edge cracking moderate, patching and utility cut patching high and potholes moderate. The results of measuring the dimensions of the damage were then outlined in a survey form, as depicted in Table 2.

Table 2
Survey data in segment 102

Airfield Asphalt Pavement Sketch: Condition Survey Data Sheet for Sample Unit				Sketch: 			
1. Alligator Cracking (m2) 2. Bleeding (m2) 3. Block Cracking (m2) 4. Bumps and Sags (m) 5. Corrugation (m2) 6. Depression (m2) 7. Edge Cracking (m)			8. Joint Reflection Cracks (m) 9. Lane/Shoulder drop of (m2) 10. Long Cracking (m2) 11. Patching (m2) 12. Polished Aggregate (m) 13. Pothole (m2) 14. Rail Road Crossing (m2)			15. Rutting (m) 16. Shoving (m) 17. Slipped Cracking (m2) 18. Swell (m2) 19. Ravelling (m2)	
Segment	STA	Distress Severity	Quantity (m)		Total	Density	Deduct Value
102	19+050 - 19+100	2M	7.2		7.2	2.06	5
		3M	7.2		7.2	2.06	8
		7M	4.5		4.5	1.29	11
		10H	2.2	1.2	3.4	0.97	18
		1L	2.3		2.3	0.66	7
		13M	1.1	1.4	2.5	0.71	78

After obtaining the TDV of each damage level, the density value was determined using Eq. (1). The following presents the example of density calculation in segment 102:

i. Bleeding (Moderate)

$$Density = \frac{7,2}{7\,x\,50}\,x\,100\% = 2,06$$

ii. Block Cracking (Moderate)

$$Density = \frac{7,2}{7\,x\,50}\,x\,100\% = 2,06$$

iii. Edge Cracking (Moderate)

$$Density = \frac{4,5}{7\,x\,50}\,x\,100\% = 1,29$$

iv. Patching (Moderate)

$$Density = \frac{3,4}{7\,x\,50}\,x\,100\% = 0,97$$

v. Alligator Cracking (Low)

$$Density = \frac{2,3}{7\,x\,50}\,x\,100\% = 0,66$$

vi. Potholes (Low)

$$Density = \frac{3,6}{7 \, x \, 50} \, x \, 100\% = 1,03$$

The dominant distress occurred on the roads 6 km long Yogyakarta-Kaliurang Provincial Road Section were patching (36.31%) and alligator crack distress (12.30%) (Table 3).

Table 3
Pavement distress type in Yogyakarta-Kaliurang provincial road section

No.	Type of Pavement Distress	Quantity	Percentage
1	**Alligator Cracking (m2)**	**313.53**	**12.30%**
2	Bleeding (m2)	126.32	4.96%
3	Block Cracking (m2)	244.11	9.58%
4	Bumps and Sags (m)	36.3	1.42%
5	Corrugation (m2)	109.79	4.31%
6	Depression (m2)	35.2	1.38%
7	Edge Cracking (m)	160.78	6.31%
8	Joint Reflection Cracks (m)	8.13	0.32%
9	Lane/Shoulder drop of (m2)	102.66	4.03%
10	Long Cracking (m2)	90.3	3.54%
11	**Patching (m2)**	**925.36**	**36.31%**
12	Polished Aggregate (m)	60.42	2.37%
13	Pothole (m2)	60.134	2.36%
15	Rutting (m)	129.73	5.09%
16	Shoving (m)	6.7	0.26%
17	Slipped Cracking (m2)	50.18	1.97%
18	Swell (m2)	25.41	1.00%
19	Ravelling (m2)	63.44	2.49%

Patching is dealing with damage caused by the large number of heavy vehicles passing by, especially trucks carrying sand, as reported by Harian Jogja [23]. Patching type damage causes discomfort for road users. An example of an image of patching damage and alligator cracks can be seen in Figure 6.

(Patching) (Alligator Crack)

Fig. 6. Patching and alligator crack distress type

3.2 Deduct Value

The DV was obtained from a graph of the relationship between density and the type and level of damage in a segment. The following is the DV in segment 102. Figure 7 to Figure 12 exhibit the DV results. The DV of bleeding, block cracking, edge cracking, patching, alligator cracking and potholes was 2.06, 2.06, 1.29, 0.97, 0.66 and 0.71, respectively.

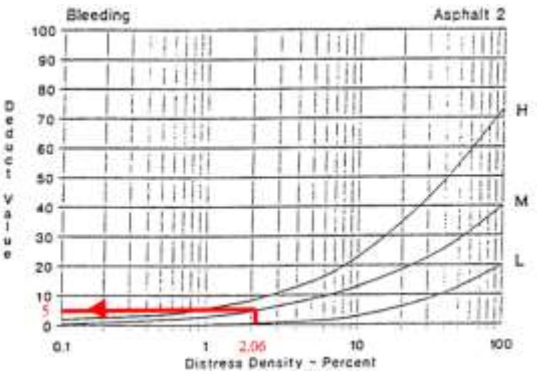


Fig. 7. Relationship curve of DV with distress severity in bleeding (moderate)

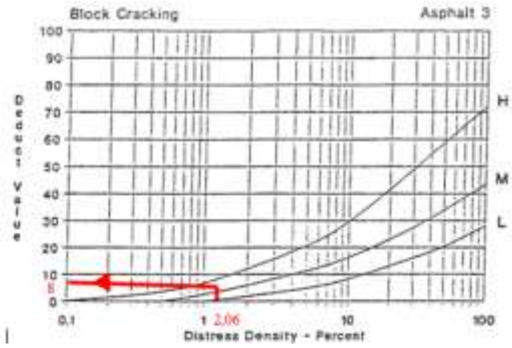


Fig. 8. Relationship curve of DV with distress severity in block cracking (moderate)

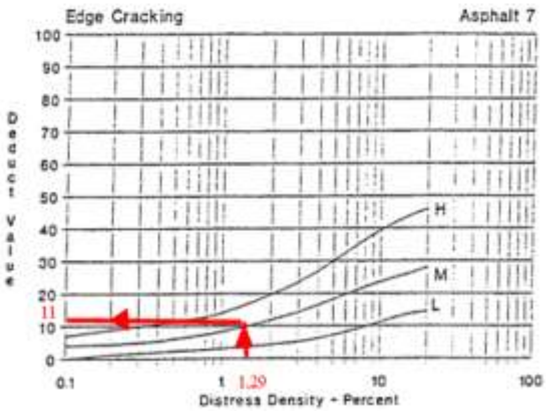


Fig. 9. Relationship curve of DV with distress severity in edge cracking

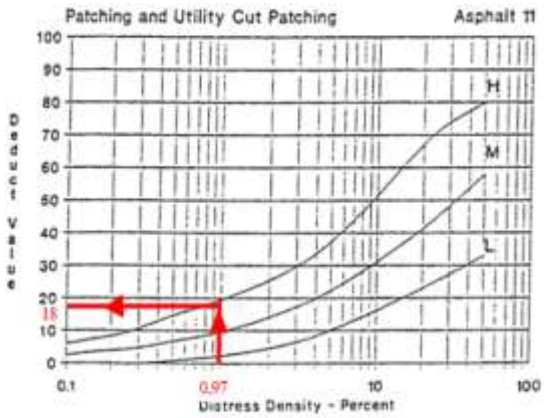


Fig. 10. Relationship curve of DV with distress severity in patching

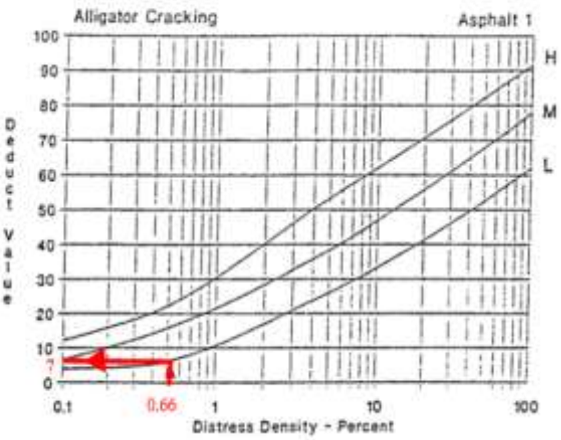


Fig. 11. Relationship curve of DV with distress severity in alligator cracking (low)

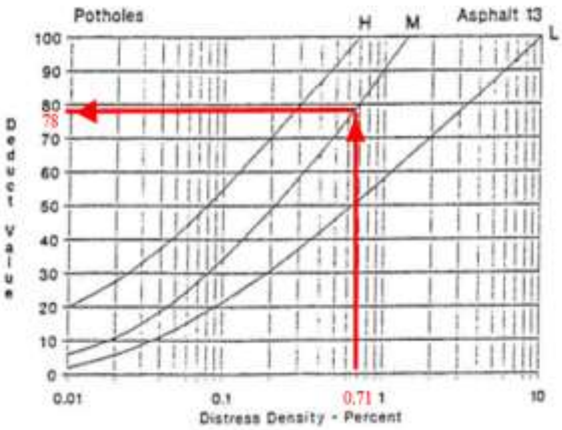


Fig. 12. Relationship curve of DV with distress severity in potholes (moderate)

The DV was obtained and then utilized to determine the max deduct value (HDV_i) in segment 102. The HDV_i obtained a value of 78. Furthermore, Eq. (5) was employed to calculate the Mi, yielding a value of 3.02. If the value of **Mi** is less than the number q= 6, as can be seen in Table 4, 90% of the smallest DV (DV min) was employed, generating a DV min of 4.5.

Table 4
The results of determining the Q-value

Segment	STA	Deduct Value	Max DV	M	#DV						TDV	Q	CDV
102	19+050 - 19+100	5	78	3.02	78	18	11	8	7	4.5	127	6	62
		8			78	18	11	8	7	2	124	5	63
		11			78	18	11	8	2	2	119	4	68
		18			78	18	11	2	2	2	113	3	70
		7			78	18	2	2	2	2	104	2	75
		78			78	2	2	2	2	2	88	1	88

Note: Mi = 3.02 < q = 6, then use 0.9 ✕ 5 = 4.5

3.3 Total Deduct Value (TDV) and Corrected Deduct Value (CDV)

The TDV was obtained from the DV summed up on each q sorted in segment 102 (STA 19+100 to 19+100). As listed in Table 4, the TDV was q6 = 127, q5 = 124, q4 = 119, q3 = 113, q2 = 104, and q1 = 88. The CDV was calculated based on the relationship of the graph curve between the CDV and the TDV at each q obtained. The following is an example of CDV analysis at STA 19 + 100 with q6 (the number of DV greater than 2 is 6). As illustrated in Figure 13, the CDV with q equal to 6 was 62.

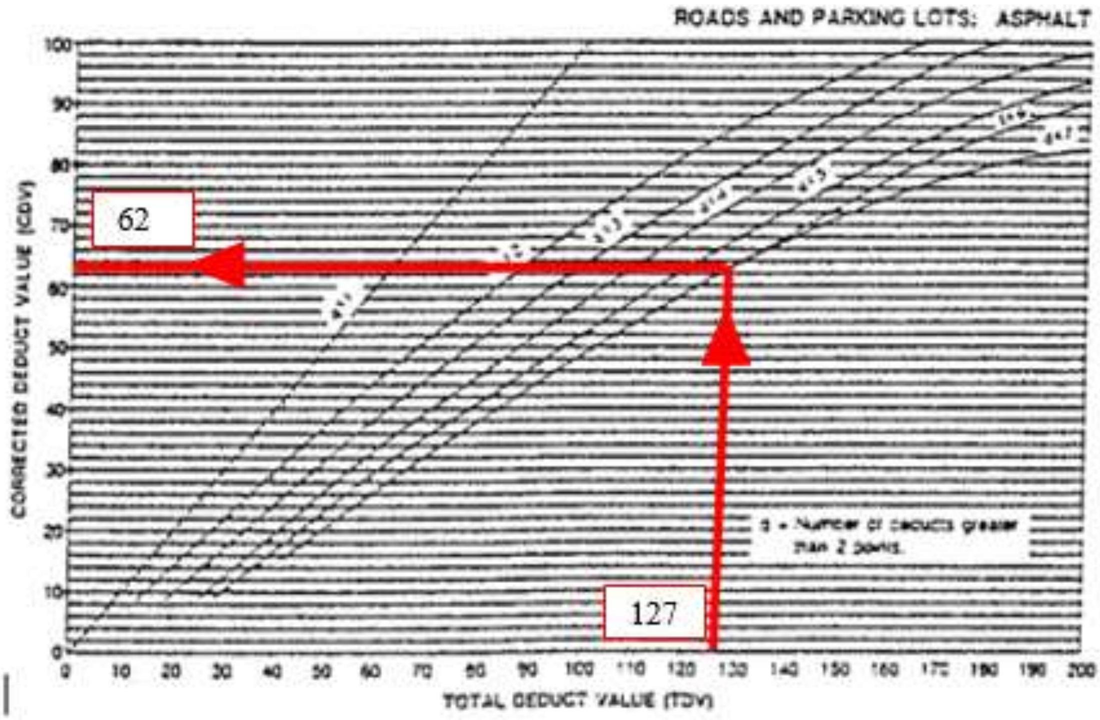


Fig. 13. Relationship curve of TDV with CDV at q6

3.4 Pavement Condition Index (PCI)

The PCI was attained after obtaining the CDV using Eq. (3). An example of PCI calculation in segment 102 with the highest CDV was 12% (100-CDV). Hence, in segment 102, a PCI of 12% was obtained, signifying a serious pavement damage condition. Table 5 lists the PCI from segments 1 to 120, acquiring an average PCI of 59.4%, implying a fair pavement damage condition.

In short, the pavement with the lowest value was in segment 102, falling within a serious condition, as portrayed in Figure 14.

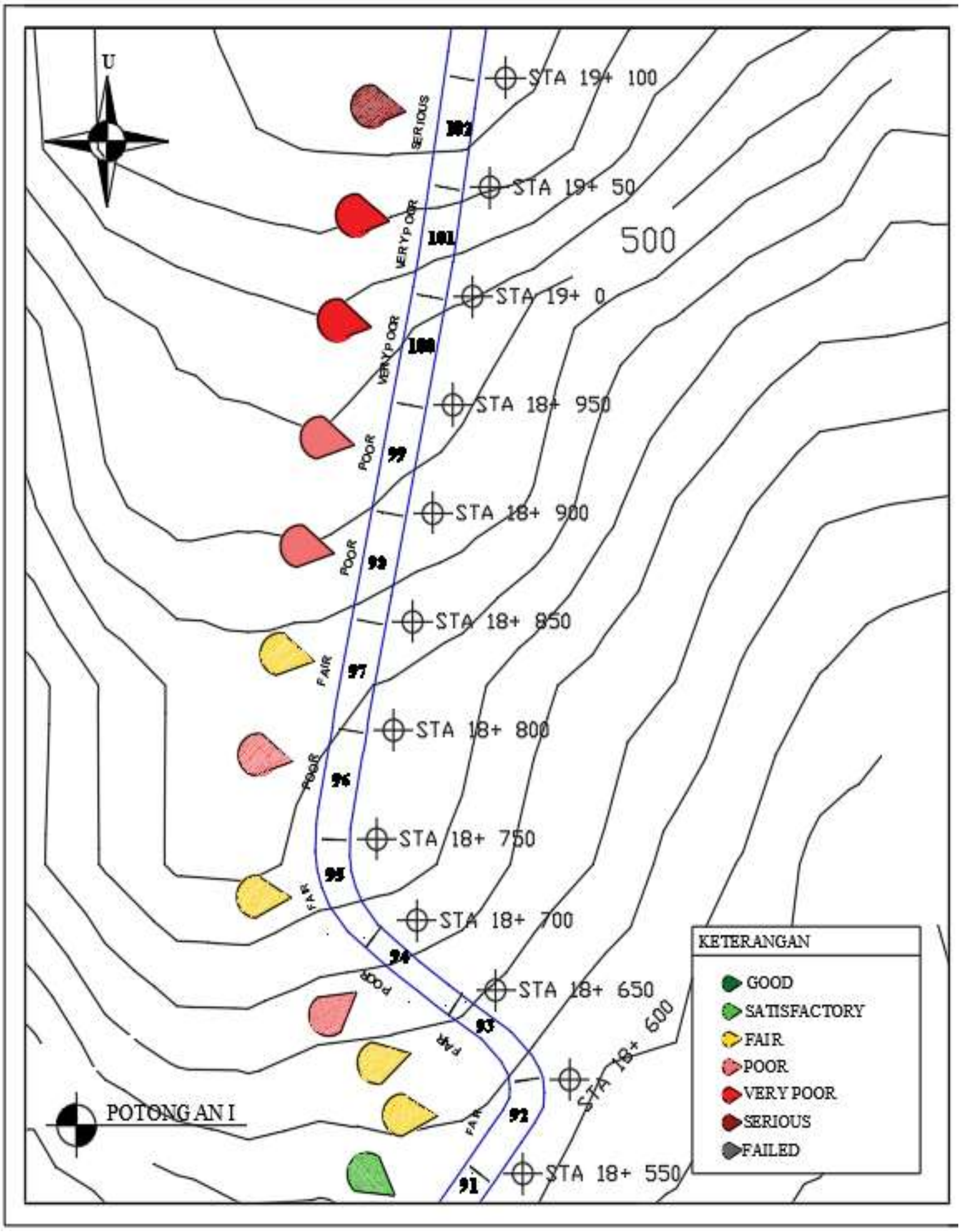


Fig. 14. Cutout layout in segment 102

Table 5
Results of determining the PCI and damage level at each stationing

STA	Segment	Condition	STA	Segment	Condition	STA	Segment	Condition	STA	Segment	Condition
14+000 - 14+050	1	Poor	15+500 - 15+550	31	Very Poor	17+000 - 17+050	61	Good	18+500 - 18+550	91	Satisfactory
14+050 - 14+100	2	Very Poor	15+550 - 15+600	32	Fair	17+050 - 17+100	62	Good	18+550 - 18+600	92	Fair
14+100 - 14+150	3	Poor	15+600 - 15+650	33	Fair	17+100 - 17+150	63	Good	18+600 - 18+650	93	Fair
14+150 - 14+200	4	Fair	15+650 - 15+700	34	Very Poor	17+150 - 17+200	64	Satisfactory	18+650 - 18+700	94	Poor
14+200 - 14+250	5	Poor	15+700 - 15+750	35	Fair	17+200 - 17+250	65	Poor	18+700 - 18+750	95	Fair
14+250 - 14+300	6	Poor	15+750 - 15+800	36	Poor	17+250 - 17+300	66	Very Poor	18+750 - 18+800	96	Poor
14+300 - 14+350	7	Fair	15+800 - 15+850	37	Fair	17+300 - 17+350	67	Poor	18+800 - 18+850	97	Fair
14+350 - 14+400	8	Satisfactory	15+850 - 15+900	38	Fair	17+350 - 17+400	68	Very Poor	18+850 - 18+900	98	Poor
14+400 - 14+450	9	Good	15+900 - 15+950	39	Poor	17+400 - 17+450	69	Fair	18+900 - 18+950	99	Poor
14+450 - 14+500	10	Good	15+950 - 16+000	40	Fair	17+450 - 17+500	70	Poor	18+950 - 19+000	100	Very Poor
14+500 - 14+550	11	Good	16+000 - 16+050	41	Satisfactory	17+500 - 17+550	71	Fair	19+000 - 19+050	101	Very Poor
14+550 - 14+600	12	Satisfactory	16+050 - 16+100	42	Poor	17+550 - 17+600	72	Fair	19+050 - 19+100	102	Serious
14+600 - 14+650	13	Satisfactory	16+100 - 16+150	43	Satisfactory	17+600 - 17+650	73	Poor	19+100 - 19+150	103	Very Poor
14+650 - 14+700	14	Poor	16+150 - 16+200	44	Poor	17+650 - 17+700	74	Fair	19+150 - 19+200	104	Poor
14+700 - 14+750	15	Very Poor	16+200 - 16+250	45	Fair	17+700 - 17+750	75	Good	19+200 - 19+250	105	Good
14+750 - 14+800	16	Poor	16+250 - 16+300	46	Satisfactory	17+750 - 17+800	76	Serious	19+250 - 19+300	106	Poor
14+800 - 14+850	17	Poor	16+300 - 16+350	47	Fair	17+800 - 17+850	77	Poor	19+300 - 19+350	107	Fair

14+850 - 14+900	18	Fair	16+350 - 16+400	48	Fair	17+850 - 17+900	78	Fair	19+350 - 19+400	108	Serious
14+900 - 14+950	19	Fair	16+400 - 16+450	49	Satisfactory	17+900 - 17+950	79	Fair	19+400 - 19+450	109	Poor
14+950 - 15+000	20	Fair	16+450 - 16+500	50	Poor	17+950 - 18+000	80	Poor	19+450 - 19+500	110	Very Poor
15+000 - 15+050	21	Good	16+500 - 16+550	51	Good	18+000 - 18+050	81	Fair	19+500 - 19+550	111	Good
15+050 - 15+100	22	Good	16+550 - 16+600	52	Satisfactory	18+050 - 18+100	82	Fair	19+550 - 19+600	112	Fair
15+100 - 15+150	23	Poor	16+600 - 16+650	53	Poor	18+100 - 18+150	83	Fair	19+600 - 19+650	113	Satisfactory
15+150 - 15+200	24	Fair	16+650 - 16+700	54	Fair	18+150 - 18+200	84	Fair	19+650 - 19+700	114	Fair
15+200 - 15+250	25	Serious	16+700 - 16+750	55	Good	18+200 - 18+250	85	Fair	19+700 - 19+750	115	Satisfactory
15+250 - 15+300	26	Poor	16+750 - 16+800	56	Fair	18+250 - 18+300	86	Satisfactory	19+750 - 19+800	116	Fair
15+300 - 15+350	27	Fair	16+800 - 16+850	57	Fair	18+300 - 18+350	87	Very Poor	19+800 - 19+850	117	Very Poor
15+350 - 15+400	28	Poor	16+850 - 16+900	58	Very Poor	18+350 - 18+400	88	Poor	19+850 - 19+900	118	Fair
15+400 - 15+450	29	Poor	16+900 - 16+950	59	Good	18+400 - 18+450	89	Fair	19+900 - 19+950	119	Fair
15+450 - 15+5000	30	Fair	16+950 - 17+000	60	Good	18+450 - 18+500	90	Satisfactory	19+950 - 20+000	120	Poor

3.5 Prediction of Remaining Service Life

The prediction of the remaining service life of the road was obtained from the PCI calculation, attaining a value of 59.4%. Hence, the Yogyakarta-Kaliurang Road had a remaining service life of 1 to 5 years, as displayed in Table 6.

Table 6
Estimated average remaining service life of the Yogyakarta-Kaliurang Road

Freeway	Arterial	Collector	Local	Time of Improvement	Remaining Service Life (Years)
>85	>85	>80	>80	Adequate	11-20 Years
85-76	85-76	80-71	80-66	6-10 Years	6-10 Years
75-66	75-66	70-51	65-46	1-5 Years	1-5 Years
65-60	55-50	50-45	45-40	New Rehabilitate	0.5-0.9 Years
<60	<50	<45	<40	New Rehabilitate	0-0.4 Years

4. Conclusions

The observations and analysis of the Yogyakarta-Kaliurang Provincial Road uncovered various types of damage but the most dominant type of damage was patching with a percentage of 36.31%. Patching is dealing with damage caused by the large number of heavy vehicles passing by, especially trucks carrying sand [21]. Patching type damage causes discomfort for road users. Some parts of the road experienced quite a lot of high-level damage, particularly between STA 18+650 and STA 18+700. Segments 1 to 120 acquired an average PCI of 59.4%, indicating a fair pavement damage condition. STA 15+000 to STA 15+100 demonstrated the highest pavement index of 100%, implying a good condition. In contrast, STA 19+050 to STA 19+100 depicted the lowest pavement index of 12%, signifying a serious pavement condition. The prediction analysis on the average PCI data of the Yogyakarta-Kaliurang Road produced an average remaining life of 1 to 5 years. The highest remaining service life of the road was 11 to 20 years, at STA 14+400 to STA 14+450. Conversely, the lowest service life was 0 to 0.4 years at STA 19+050 to STA 19+100.

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