International Journal of Sustainable Building, Infrastructure, and Environment

Analysis of Road Surface Distress Using Pavement Condition Index (PCI) and Bina Marga Method (Case Study: Jalan KH. Abdurahman Wahid, STA. 0+000 – STA. 1+950, Wonosobo Subdistrict)

Galang Nugroho[1], Vian Guntur Saputra[1], Slamet Budirahardjo[1], Agustina Wardani[1]

[1]Department of Civil Engineering, Faculty of Engineering and Informatics, PGRI University of Semarang, Jl. Sidodadi Timur No. 24, Karangtempel, Semarang Timur District, Semarang City, Central Java, Indonesia

E-mail: galangn10@gmail.com

Abstract. *Wonosobo is one of the tourist destinations in Central Java, making highways a vital element in supporting the mobility of both residents and visitors. One of the strategic roads is Jalan KH. Abdurahman Wahid, which connects the center of Wonosobo City with the Dieng Tourism Area. The surface condition of this road segment shows various types of damage that have the potential to disrupt transportation flow. This study aims to analyze the surface layer damage on Jalan KH. Abdurahman Wahid from STA. 0+000 to STA. 1+950 in Wonosobo District using two approaches: the Pavement Condition Index (PCI) method and the Bina Marga Method. The PCI method is used to evaluate the extent of damage based on visual inspection results, while the Bina Marga Method is employed to identify types of damage and determine their handling priority levels through the calculation of Priority Order (Urutan Prioritas/UP). The survey and analysis results indicate eight types of damage based on the Pavement Condition Index (PCI), with an average PCI score of 35.62 (categorized as Very Poor), and the lowest score of 20 (categorized as Serious) found in sample units 3, 10, and 13. According to the Bina Marga Method, six types of damage were identified with a Priority Order (UP) value of 6, indicating that the road segment falls into the priority category for Periodic Maintenance. It can be concluded that this road segment requires immediate treatment either in specific sections or along the entire stretch. The analysis results are expected to serve as a consideration for relevant agencies in managing road infrastructure effectively and sustainably*.

Keyword: *Road damage, Pavement Condition Index, Bina Marga Method, Flexible pavement, Road maintenance*

1. INTRODUCTION

Roads are one of the most vital components of transportation infrastructure, playing a key role in supporting population mobility, goods distribution, and regional economic growth. According to the

Law of the Republic of Indonesia Number 22 of 2009 on Road Traffic and Transportation [1], a road is defined as a land transportation facility comprising all parts of the road—including its complementary structures and accessories—intended for vehicular and pedestrian traffic. Consequently, maintaining roads in good condition is not only essential for ensuring smooth traffic flow but also for safeguarding the safety and comfort of road users.

However, over time, road quality tends to deteriorate due to factors such as high traffic loads, extreme weather conditions, and pavement aging. If left unaddressed, road damage can increase the risk of accidents and raise vehicle operating costs. Therefore, systematic evaluation of road conditions is crucial for effective maintenance planning. The Pavement Condition Index (PCI) method and the Bina Marga technical guidelines [2] are two widely used approaches for assessing pavement conditions and determining maintenance priority based on the level of distress observed.

Given the strategic function of Jalan KH. Abdurahman Wahid as a primary access route to the Dieng Tourism Area, the presence of damage along this road section can significantly affect mobility efficiency and road user safety.

The objectives of this study are as follows:

1) To analyze the level of pavement surface distress along Jalan KH. Abdurahman Wahid STA. 0+000 – STA. 1+950 in Wonosobo District;
2) To determine the maintenance priority for pavement damage along Jalan KH. Abdurahman Wahid STA. 0+000 – STA. 1+950 in Wonosobo District.

2. METHODS

2.1. Research Location

This study was conducted along Jalan KH. Abdurahman Wahid, located in Wonosobo Subdistrict, Wonosobo Regency, Central Java Province.

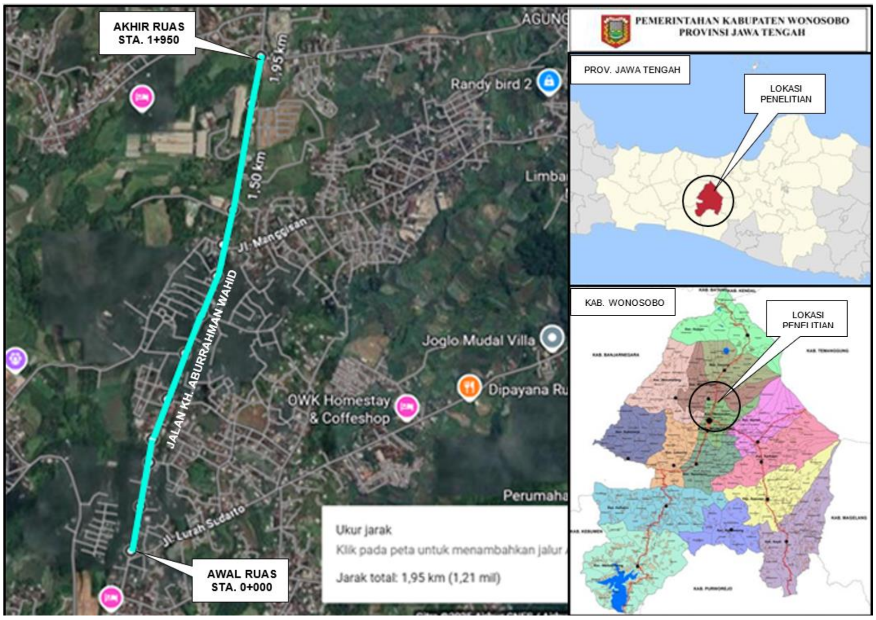


Figure 1. Research Location Map
(Source: Author's Data, 2025)

2.2. Survey Implementation Method

1) Road Condition Survey Using the Pavement Condition Index (PCI) Method was conducted in accordance with ASTM D 6433-07 *Standard Practice for Roads and Parking Lots Pavement Condition Indeks Surveys* [3];

2) Road condition survey based on the Bina Marga Method was carried out with reference to the Guidelines *for the Preparation of Urban Road Maintenance Programs* (Pedoman Tata Cara Penyusunan Program Pemeliharaan Jalan Kota) No. 018/T/BNKT/1990, published by the Directorate General of Highways (Direktorat Jenderal Bina Marga) [4].

2.3. Data Collection

1) Primary Data

Primary data were obtained through direct field surveys as follows:

a. Roadway topography;
b. Road geometry;
c. Assessment of pavement surface distress types.

2) Secondary Data

Secondary data were obtained from relevant agencies and government offices as follows:

a. Average Daily Traffic (ADT) data;
b. Road section location map;
c. Road status and classification information.

2.4. Data Processing Method

1) Data processing using Pavement Condition Index (PCI)

a. Calculation of Density

The density value is determined using *Eq. (1)* as follows:

$$Density\ (\%) = \left(\frac{Ad}{As}\right) x\ 100\% \quad (1)$$

Calculation of Deduct Value (DV)

The Deduct Value (DV) is obtained by entering the Density value into the Deduct Value (DV) chart for the corresponding type of pavement distress.

b. Determination of Allowable Maximum Deduct Value (m)

1. Identify the Highest Deduct Values (HDV).
2. Calculate the value of m using *Eq. (2)* as follows:

$$m = 1 + \left(\frac{9}{98}\right) x(100 - HDV) \quad (2)$$

3. Compare the value of m with the total Deduct Value (q).

c. Calculation of Total Deduct Value (TDV)

The Total Deduct Value (TDV) is obtained by summing the Deduct Values (DV) for each type and severity level of distress within a given segment.

d. Calculation of Corrected Deduct Value (CDV)

The Corrected Deduct Value (CDV) is determined by establishing the relationship between the Total Deduct Value (TDV) and the value of q using the TDV–CDV relationship chart.

e. Calculation of Pavement Condition Index (PCI) for Each Segment

The Pavement Condition Index (PCI) for each segment is calculated using Eq. *(3)* as follows:

$$PCI_{(s)} = 100 - CDV_{max} \quad (3)$$

f. Determination of the Average Pavement Condition Index (PCI)

$$PCI = \sum \frac{\sum PCI_{(s)}}{n} \quad (4)$$

2) Data Processing Using the Bina Marga Method

a. Processing of Average Daily Traffic (ADT) data.
b. Determination of Traffic Class based on *Table 1* below.

Table 1. Traffic Class

Average Daily Traffic (ADT)	Road Class Value
< 20	0
20 - 50	1
50 - 200	2
200 - 500	3
500 - 2000	4
2000 - 5000	5
5000 - 20000	6
20000 - 50000	7
> 50000	8

(Source: Bina Marga No. 018/T/BNKT/1990)

c. Determination of Distress Type and Severity
   The assessment of pavement distress types is classified according to *Table 2* below.

Table 2. Road Condition Rating Based on Distress Type

Cracking	
Distress Tipe	**Rating**
E. Alligator Cracking	5
D. Random Cracking	4
C. Transverse Cracking	3
B. Longitudinal Cracking	2
A. None	1
Crack Width	**Rating**
D. > 2 mm	3
C. 1 - 2 mm	2
B. < 1 mm	1
A. None	0
Percentage of Distress Area	
Area	**Rating**
D. > 30 %	3
C. 10 - 30 %	2
B. < 10 %	1
A. 0	0
Rutting	
Depth	**Angka**
E. > 20 mm	7
D. 11 - 20 mm	5
C. 6 - 10 mm	3
B. 0 - 5 mm	1
A. None	0
Patching and Potholes	
Area	**Rating**
D. > 30 %	3
C. 20 - 30 %	2
B. 10 - 20 %	1
A. < 10 %	0

(Source: Bina Marga No. 018/T/BNKT/1990)

Table 2. (continued)

Surface Textures	
Type	**Rating**
E. Disintegration	4
D. Aggregate Loss	3
C. Rough (Hungry)	2
B. Fatty Surface	1
A. Close Texture	0
Depression	
Depth	**Rating**
D. > 5/100 m	4
C. 2 - 5/100 m	2
B. 0 - 2/100 m	1
A. None	0

(Source: Bina Marga No. 018/T/BNKT/1990)

d. Determination of Damage Score and Road Condition Rating
The Total Damage Score is used to quantitatively evaluate the physical condition of a given road segment. The Total Damage Score is classified into 9 (nine) categories, as shown in *Table 3*.

Table 3. Road Condition Rating Based on Total Damage Score

Total Damage Score	Road Condition Rating
26 - 29	9
22 - 25	8
19 - 21	7
16 - 18	6
13 - 15	5
10 - 12	4
7 - 9	3
4 - 7	2
0 - 3	1

(Source: Bina Marga No. 018/T/BNKT/1990)

e. Determination of Priority Order (UP)
The Priority Order (UP) is calculated using *Eq. (5)* as follows:

$$\text{UP} = 17 - (\mathit{Traffic}\ \text{Class} + \text{Road Condition Rating}) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

The identification of Priority Order (UP) is presented in *Table 4*.

Table 4. Priority Order Classification

Priority Order (UP)	Priority Identification
0 – 3	Roads in this priority range are included in the Improvement Program.
4 – 6	Roads in this priority range are included in the Periodic Maintenance Program.
7	Roads in this priority range are included in the Routine Maintenance Program.

(Source: Bina Marga No. 018/T/BNKT/1990)

3. RESULTS AND DISCUSSION

3.1. Survey Data

Based on the survey results, Jalan KH. Abdurahman Wahid is located in Wonosobo Subdistrict, Wonosobo Regency, stretching from STA. 0+000 to STA. 1+950, with a total length of 1,950 meters and an average width of 7 meters. This road functions as a Class III Primary Collector Road. Geometrically, it is classified as a 2/2 UD road type, consisting of two undivided two-way lanes, with one lane in each direction and a lane width of 3.5 meters.

3.2. Result of Pavement Condition Index (PCI) Analysis

1) Number of Sample Units

The number of sample units was determined as follows:

Total road segment length : 1950 m
Average road width : 7 m
Total road area : 13.650 m²
Sample unit area : 350 m²
Number of sample units (N): 39 sampel

Thus, a total of 39 sample units were obtained, each with a length of 100 m and a width of 3.5 m.

2) Minimum Number of Sample Units

The minimum number of sample units to be evaluated (n) is determined using *Eq. (6)* as follows:

$$n = \frac{N_{s^2}}{\frac{e^2}{4}(N-1)+s^2} \quad (6)$$

$$n = \frac{39\,(10)^2}{\frac{(5)^2}{4}(39-1)+(10)^2}$$

$n = 11.56$ rounded to 12

3) Interval of Sample Units

The total number of sample units is 39. Considering that the minimum number of sample units required is 12, a total of 13 sample units were selected for further analysis. The sampling interval (I) is determined using Eq. (7) as follows:

$$I = \frac{N}{n} \quad (7)$$

$$I = \frac{39}{13} = 3$$

$I = 3$

The distribution of the selected sample units is presented in Figure 2.

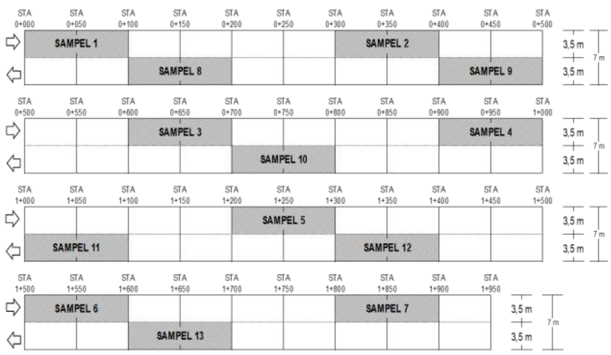


Figure 2. Distribution of Sample Unit Segments
(Source: Author's Data, 2025)

4) Analysis Procedure

As an example, the calculation of the Pavement Condition Index (PCI) for Sample Unit 8 was performed for the segment from STA. 0+100 to STA. 0+200 on the right lane. Within this unit, two types of pavement distress were identified: Alligator Cracking with a severity level of *Medium*, and Patching and Utility Cut Patching, also with a severity level of *Medium*.

a. Calculation of Density

Using *Eq. (1)*, the density of each distress type is calculated as follows:

1. Alligator Cracking

$$Density = \frac{(11{,}50\ x\ 1{,}20)}{350} x\ 100\%$$
$$Density = 3.943\ \%$$

2. Patching and Utility Cut Patching

$$Density = \frac{(7{,}20\ x\ 1{,}60)}{350} x\ 100\%$$
$$Density = 3.291\ \%$$

b. Determination of Deduct Value (DV)

1. Alligator Cracking

Based on the relationship between Density and the severity level of the distress, the DV for Alligator Cracking is determined to be 36. This relationship is illustrated in Figure 3.

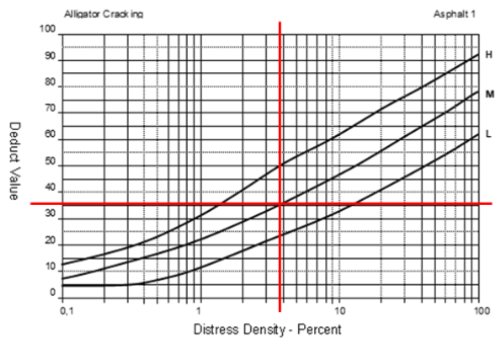


Figure 3. DV of Alligator Cracking
(Source: Author's Data, 2025)

2. Patching *and Utility Cut Patching*

Based on the relationship between Density and the severity level of the distress, the DV for Patching and Utility Cut Patching is determined to be 18. This relationship is illustrated in Figure 4.

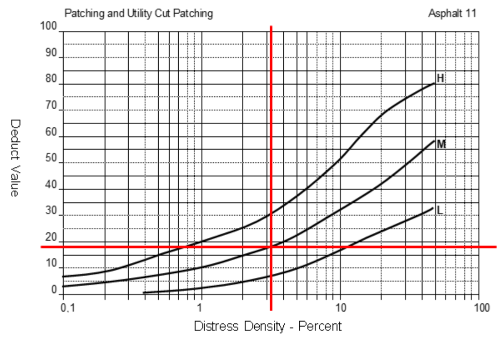


Figure 4. DV of Patching and Utility Cut Patching
(Source: Author's Data, 2025)

c. Determination of Highest deduct Values (HDV)
In Sample Unit 8, located between STA. 0+100 and STA. 0+200 on the right lane, Alligator Cracking was found to have a DV of 36, whereas Patching and Utility Cut Patching had a DV of 18.
In determining the Highest Deduct Value (HDV), only DVs greater than 5 are considered, and the highest value among them is selected. Therefore, the HDV for this sample unit is 36.

d. Calculation of *m* (Allowable Maximum Deduct Value)
The allowable maximum Deduct Value (*m*) is calculated using *Eq. (2)* as follows:

$$m = 1 + \left(\frac{9}{98}\right) x(100 - HDV)$$

$$m = 1 + \left(\frac{9}{98}\right) x(100 - 36)$$

$$m = 6.88$$

e. Comparison of *m* and Total Deduct Value (DV)/q
For Sample Unit 8, located between STA. 0+100 and STA. 0+200 on the right lane, the calculated value of m is 6.88, while the total Deduct Value (q) is 2. The value used in the subsequent calculation is q = 2.

f. Determination of Total Deduct Value (TDV)
In Sample Unit 8, located between STA. 0+100 and STA. 0+200 on the right lane, two types of pavement distress were observed. The first distress type, Alligator Cracking, yields a Total Deduct Value (TDV) of: TDV = 36 + 18 = 54. Since the TDV exceeds the allowable threshold, the value used in the subsequent calculation is q = 2.
The second distress type, Patching and Utility Cut Patching, yields a TDV of: 36 + 2 = 38. Because this TDV is relatively lower compared to the first distress type, the value used in the PCI calculation is q = 1.

g. Determination of Maximum Corrected Deduct Value (CDV)
1. Alligator Cracking (q = 2)
Based on the relationship between the Total Deduct Value (TDV) and q = 2, the Corrected Deduct Value (CDV) for Alligator Cracking is determined to be 41, as shown in Figure 5.

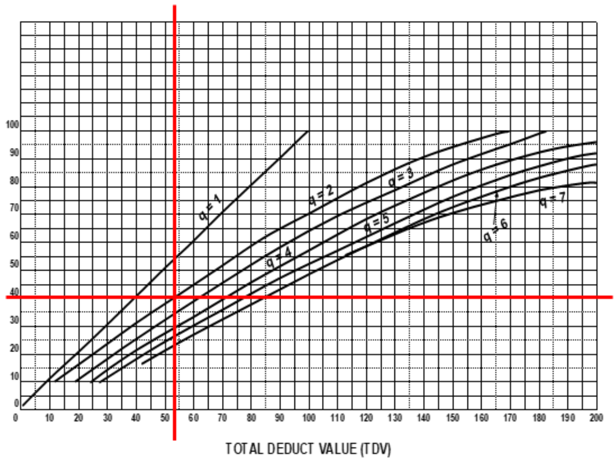
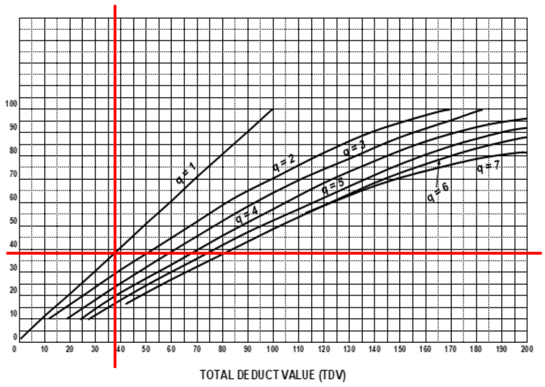


Figure 5. CDV for Alligator Cracking
(Source: Author's Data, 2025)

2. Patching and Utility Cut Patching
   Similarly, based on the relationship between TDV and q = 1, the Corrected Deduct Value (CDV) for Patching and Utility Cut Patching is determined to be 38, also shown in Figure 5.



Gambar 6. CDV *Patching and Utility Cut Patching*
(Source: Author's Data, 2025)

h. Determination of Maximum Corrected Deduct Value (CDV)
   For Sample Unit 8, the CDV for Alligator Cracking is 41, while the CDV for Patching and Utility Cut Patching is 38. The Maximum Corrected Deduct Value is therefore taken as the highest of the two values, namely 41.

i. Determination of Pavement Condition Index (PCI)
   Calculated using *Eq. (4)* as follows:
   $PCI_{(s)} = 100 - CDV_{max}$
   $PCI_{(s)} = 100 - 41 = 59$
   Thus, the PCI value for Sample Unit 8 is 59.

j. Recapitulation of Pavement Condition Index (PCI)
   After calculating the Pavement Condition Index (PCI) for each sample unit, the results and the overall average PCI value are presented in Table 5.

Table 5. Recapitulation of Pavement Condition Index (PCI)

Sample Unit	STA	Position	$PCI_{(s)}$
1	0+000 – 0+100	Left Lane	37
2	0+300 – 0+400	Left Lane	55
3	0+600 – 0+700	Left Lane	20
4	0+900 – 1+000	Left Lane	56
5	1+200 – 1+300	Left Lane	40
6	1+500 – 1+600	Left Lane	30
7	1+800 – 1+900	Left Lane	29
8	0+100 – 0+200	Right Lane	59
9	0+400 – 0+500	Right Lane	38
10	0+700 – 0+800	Right Lane	20
11	1+000 – 1+100	Right Lane	29
12	1+300 – 1+400	Right Lane	30
13	1+600 – 1+700	Right Lane	20
Average			**35.62**

(Source: Author's Data, 2025)

Based on the average Pavement Condition Index (PCI) value of 35.62, the pavement segment along Jalan KH. Abdurahman Wahid from STA. 0+000 to STA. 1+950 falls into the Very Poor category, as shown in Figure 7.

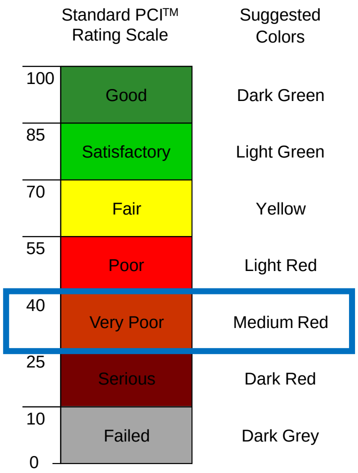


Figure 7. Pavement Condition Index (PCI) Rating Scale
(Source: Author's Data, 2025)

3.3. Results of Bina Marga Method Analysis

The road condition survey identified the types of distress, dimensions of the damaged areas, and their locations along Jalan KH. Abdurahman Wahid from STA. 0+000 to STA. 1+950 in Wonosobo Subdistrict. The recapitulation of the survey results is presented in Table 6.

Table 6. Recapitulation of Bina Marga Survey Results

No	Type of Distress	Area (m^2)	Percentage of Total Road Area
1	Aggregate Loss	137.15	1.00%
2	Potholes	0	0.00%
3	Patching	1364.09	10.09%
4	Transverse Crack	61.7	0.51%
5	Alligator Crack	377.82	3.13%
6	Random Crack	39.68	0.34%
7	Depression	155.05	1.33%
	Total	**2,135.49**	**15.64%**

(Source: Author's Data, 2025)

1) Processing of Average Daily Traffic (ADT) Data
Based on the Traffic Summary Report and VC Ratio, the traffic flow was obtained as 1,275 vehicles per hour. This value was then extrapolated to represent the average 24-hour traffic volume, under the assumption that traffic flow remains relatively stable throughout the day. Consequently, the Average Daily Traffic (ADT) for Jalan KH. Abdurahman Wahid was determined to be 30,600 vehicles per day [5].

2) Determination of Traffic Class
Referring to Table 1, the ADT value of 30,600 vehicles per day falls within the range of 20,000 to 50,000 vehicles per day, classifying the road segment as Traffic Class 7.

3) Determination of Damage Scores
The results of the damage score assessment are presented in Table 7 below.

Table 7. Recapitulation of Damage Scores

Segment	STA	Total Damage Scores
1	0+000 – 0+100	7
2	0+100 – 0+200	8
3	0+200 – 0+300	3
4	0+300 – 0+400	11
5	0+400 – 0+500	10
6	0+500 – 0+600	4
7	0+600 – 0+700	3
8	0+700 – 0+800	8
9	0+800 – 0+900	14
10	0+900 – 1+000	8
11	1+000 – 1+100	11
12	1+100 – 1+200	14
13	1+200 – 1+300	14
14	1+300 – 1+400	14
15	1+400 – 1+500	10
16	1+500 – 1+600	17
17	1+600 – 1+700	12
18	1+700 – 1+800	11
19	1+800 – 1+900	12
20	1+900 – 1+950	6
	Total	**201**

(Source: Author’s Data, 2025)

4) Determination of Road Condition Rating Based on Total Damage Score
The average road condition rating is calculated by dividing the Total Damage Score by the number of segments (each 100 m in length, totaling 20 segments). The calculation is as follows:

$$Road\ Condition\ Rating = \frac{Total\ Damage\ Scores}{Number\ of\ Segments}$$

$$Road\ Condition\ Rating = \frac{201}{20} = 10.05$$

Thus, the Road Condition Rating for Jalan KH. Abdurahman Wahid, STA. 0+000 – STA. 1+950, is determined to be 4.

5) Determination of Priority Order (UP)
The Priority Order (UP) is calculated using Eq. (5) as follows:

$$UP = 17 - (Traffic\ Class + Road\ Condition\ Rating)$$

$$UP = 17 - (7 + 4)$$

$$UP = 6$$

The resulting Priority Order is 6, which places the road segment within the 4–6 priority range. According to the Bina Marga method (Table 4), this segment is categorized under the Periodic Maintenance Program.

4. CONCLUSION AND RECOMMENDATIONS

4.1. Conclusion

The conclusions of this study are as follows:

1) The surface condition of Jalan KH. Abdurahman Wahid, STA. 0+000 – STA. 1+950, is classified as Very Poor, with an average Pavement Condition Index (PCI) value of 35.62. The most dominant types of distress include Alligator Cracking, Patching and Utility Cut Patching, Depression, Weathering, and Raveling. The lowest PCI value was found in Sample Units 3, 10, and 13, with a PCI of 20, categorized as Serious.

2) Based on the Bina Marga Method, the Priority Order (UP) was determined to be 6, indicating that this road segment is classified under the Periodic Maintenance Program category.

4.2. Recommendations

The author's recommendations are as follows:

1) Considering that the Pavement Condition Index (PCI) falls within the Very Poor category and the Priority Order (UP) indicates high priority, it is recommended that the relevant agencies carry out immediate maintenance actions to prevent more severe damage and higher repair costs.
2) Regular monitoring and evaluation of road conditions should be conducted annually to maintain pavement performance in accordance with its design service life.
3) Public awareness campaigns should be conducted to encourage community participation in maintaining road conditions by avoiding damaging activities such as illegal excavation, overloading of vehicles, and to promote cleanliness of drainage systems and road shoulders.
4) Relevant agencies are advised to carefully select pavement materials for maintenance works—whether using Hotmix or alternatives such as CPHMA (Cold Paving Hot Mix Asphalt)—by considering factors such as traffic load, tropical climate conditions, availability of local materials, implementation costs, and long-term maintenance efficiency.

REFERENCES

[1] Undang-Undang *Republik* Indonesia. (2022). *Undang-Undang Nomor 2 Tahun 2022 tentang Perubahan Kedua atas Undang-Undang Nomor 38 Tahun 2004 tentang Jalan*. Lembaran Negara Republik Indonesia Tahun 2022 Nomor 9.

[2] Direktorat Jenderal Bina Marga. (2022). *Petunjuk Teknis Survei Kondisi Jalan dengan Metode PCI*. Jakarta: Kementerian PUPR.

[3] ASTM D6433-07. (2007). *Standard Practice for Roads and Parking Lots Pavement Condition Index Surveys*. American Society for Testing and Materials, Philadelphia.

[4] Bina Marga. (1990). *Tata Cara Penyusunan Program Pemeliharaan Jalan Kota*. Nomor: 018/T/BNKT/1990. Direktorat Jenderal Bina Marga, Departemen Pekerjaan Umum, Jakarta

[5] VC Ratio dan Traffic *Summary* Report. (2024). Dinas Pekerjaan Umum Bina Marga dan Cipta Karya Provinsi Jawa Tengah