JICE Journal Innovation of Civil Engineering

Vol. 5, No. 1, pp. 24-33, 2024
Submit: 24-02-2024 |
Accepted: 04-05-2024 |
Publish: 16-05-2024 |

EVALUATION OF THE LEVEL OF ROAD DAMAGE IN JELIDRO II-KUWUKAN-SAMBIKEREP ROADS USING THE PAVEMENT CONDITION INDEX (PCI) AND BINA MARGA METHOD

Thasyara Nurhijriyah*, Kurnia Hadi Putra, Theresia Maria Chandra Agusdini

Civil Engineering Department, Institut Teknologi Adhi Tama Surabaya, Surabaya, 60117, Indonesia

e-mail: thasyaranh@gmail.com

ABSTRACT

The deterioration of road quality can constrain economic and social activities and endanger road users. Small damages can escalate if not promptly addressed, leading to losses. This research aims to determine the type and level of damage on Jelidro II – Kuwukan - Sambikerep Roads STA 0+000 to STA 1+600. There are two methods for obtaining road condition values in this research, the methods are the Pavement Condition Index method and the Bina Marga method. Unlike prior studies, this research compares the effectiveness of the PCI and Bina Marga methods, particularly on class IIIC roads in urban areas. On the section of Jelidro II – Kuwukan - Sambikerep Roads, 8 types of damage were found, those are crocodile skin cracks, grade depression, edge cracks, potholes, patches, longitudinal cracks, slip cracks, and ravelling. Calculating the road condition value using the PCI method is 63.6 where the road is included in the good category. Calculations using the Bina Marga method get a priority order of 9. The two methods show that the road has the same type of treatment, that is a routine maintenance program with repair methods that can be carried out, namely surface layers such as asphalt resurfacing and patching holes.

Keywords: *Road Damage; PCI method; Bina Marga method.*

1. Introduction

The definition a road is a facility for land transportation that is useful for the development of an area. Roads can be used to meet community needs and also carry out various kinds of activities. Community needs and also carrying out various kinds of activities. Indonesia is a developing country, where developing countries need road infrastructure to connect economic activities between one region and another. Economic progress continues to have an increasing impact on traffic growth. This causes the load placed on traffic to increase and this can lead to a decrease in road quality.

Decreased road quality can become an obstacle to economic and social activities and can endanger road users. Damaged road conditions can indirectly provide less than optimal service to road users. The causes of road damage are caused by several factors such as errors during planning, overloaded vehicles passing repeatedly, inadequate maintenance on road pavement, and errors during implementation. Road pavement can be damaged prematurely if the load received is experienced overloading. Various types of damage can occur on road pavement, including grade depression, potholes, bumps, and crocodile skin cracks. How to handle it also varies for each damage that occurs. Small damage can become bigger if not treated immediately and can also cause losses. Therefore, it is necessary to improve the quality of existing road facilities and infrastructure.

Surabaya is the largest city and capital of East Java Province. The rapid population growth of the city of Surabaya causes various kinds of problems, one of which is damage to various roads in the city of Surabaya. It can be seen on the Jelidro II – Kuwukan - Sambikerep roads section, precisely

JICE Journal Innovation of Civil Engineering
Vol. 5, No. 1, pp. 24-33, 2024
Submit: 24-02-2024 |
Accepted: 04-05-2024 |
Publish: 16-05-2024 |

in West Surabaya. According to the Surabaya City Transportation Department, section Jelidro II – Kuwukan - Sambikerep roads is included in the class IIIC road category. The type of pavement on this road is flexible pavement which has a length of 1.6 km and is a 2/2 UD road type. Jelidro II – Kuwukan - Sambikerep road is an alternative road for road users who aim at shopping centers, this road is surrounded by housing, stores, and restaurants. Based on observations in the field, there are three types of vehicles across this road, namely light vehicles (pick up, private cars), motorbikes, and heavy vehicles (trucks).

This section of the road experienced light damage to heavy damage which disturbed road users. Seeing the condition of the damaged road pavement, approach methods such as the PCI and Bina Marga methods are needed which are useful for assessing the level of road damage conditions that have occurred and also aim to determine the appropriate type of road repair. Previous studies have extensively discussed the use of the PCI method or the Bina Marga method separately for road condition evaluations. However, there is a lack of comparative studies involving both methods in a specific case, particularly for class IIIC roads in urban areas such as the Jelidro II – Kuwukan - Sambikerep section. Therefore, this study aims to compare the PCI and Bina Marga methods simultaneously to identify the strengths and weaknesses of each method in the case of class IIIC roads in Surabaya.

2. Material and Method

Research requires data that is used as support to solve research problems. Both from primary and secondary data. The following is a detailed explanation regarding evaluating road damage using the Pavement Condition Index (PCI) method and the Bina Marga method.

2.1. Metode Pavement Condition Index (PCI)

Data analysis using the PCI method has the following stages:

1. Measuring the number of damage types
2. Determine the level of damage consisting of low, medium, and high
3. Define the density
4. Determining the deduct value
5. Determining Total Deduct Value (TDV)
6. Determining Corrected Deduct Value (CDV)
7. Calculate PCI value

There is a rating for each PCI value, as shown in the table below:

Table 1. Rating of PCI Value

PCI	Rating
86 – 100	Excellent
71 – 85	Very Good
56 – 60	Good
41 – 55	Fair
26 – 40	Poor
11 – 25	Very Poor
0 – 10	Failed

2.2. Bina Marga Method

The Bina Marga method is commonly used in Indonesia to prepare maintenance programs. This method has final priority order (UP) results that use damage dimension data and also daily traffic (LHR). The formula for the priority order is as follows:

UP = 17 – (LHR class + Assess Road Conditions).

Types of road handling based on UP value:

- UP 0-3 roads are included in the upgrade program

JICE Journal Innovation of Civil Engineering

Vol. 5, No. 1, pp. 24-33, 2024
Submit: 24-02-2024 |
Accepted: 04-05-2024 |
Publish: 16-05-2024 |

- UP 4-6 roads are included in the periodic maintenance program
- UP >7 roads are included in the routine maintenance program

3. Result and Discussion

3.1. PCI Method Analysis

1. Determining the Type and Level of Damaged
   Road damage data is grouped by segment. The following are the dimensions of damage at STA 0+000 – 0+100.

Table 2. Dimensions of Road Damaged

No	STA	Type of Damage	Dimensions (m)			Level	Area (m^2)	Total Area(m^2)
			L	W	d			
1	0+100 – 0+200	Edge Cracks	0,4	0,9	-	H	0,36	0,73
		Edge Cracks	0,53	0,7	-	H	0,37	
		Potholes	0,2	0,15	0,015	L	0,03	0,06
		Potholes	0,19	0,18	0,02	L	0,03	
		Ravelling	1,63	0,9	-	M	1,47	2,93
		Ravelling	0,74	0,4	-	M	0,30	
		Ravelling	1,3	0,9	-	M	1,17	
		Ravelling	1,15	0,2	-	H	0,23	0,23

2. Calculate Density Values
   The next step is to find the density with the formula:

$$\text{Density} = \frac{Ad}{As} \times 100\%$$

Density of Side Cracks (H) $= \frac{0,73}{630} \times 100\ \% = 0,12\ \%$

Density of Potholes (L) $= \frac{0,06}{630} \times 100\ \% = 0,01\ \%$

Density Ravelling (M) $= \frac{2,93}{630} \times 100\ \% = 0,47\ \%$

Density Ravelling (H) $= \frac{0,23}{630} \times 100\ \% = 0,04\ \%$

3. Determining Deduct Value
   Deduct value is determined by correlation curve from density with level of damage differentiated for each type of damage.

JICE Journal Innovation of Civil Engineering

Vol. 5, No. 1, pp. 24-33, 2024
Submit: 24-02-2024 |
Accepted: 04-05-2024 |
Publish: 16-05-2024 |

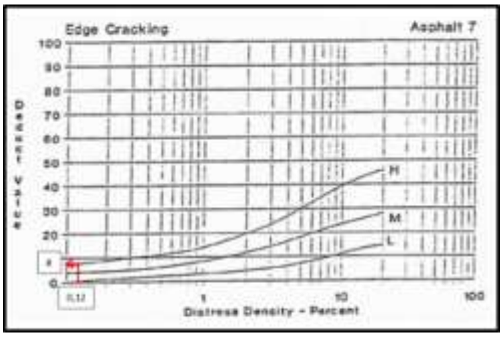

Figure 1. Correlation Curve of density and level of damage on Edge Cracks (H)

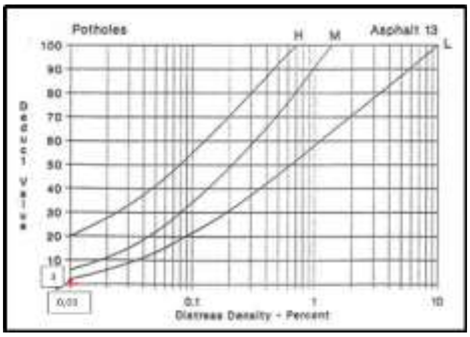

Figure 2. Correlation Curve of density and level of damage on Potholes (L)

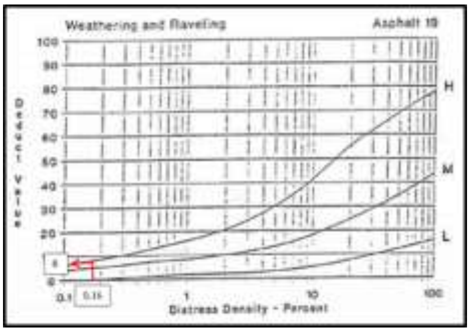

Figure 3. Correlation Curve of density and level of damage on Ravelling (H)

In Figure 3, the relationship between density and damage level for ravelling (H) is shown. The curve indicates that the deduct value increases as the density rises, reflecting more significant damage. This assessment aligns with the findings in Table 5, where segments with higher damage levels have lower PCI values.

4. Calculate the value of m
   The way to calculate the m value is to use the highest deduct value. For example, segment one at STA 0+000 until 0+100 has an HDV (the highest value of deduct value of one segment) is 8. So the value of m:

   $$m = 1 + 9/98 \times (100 - HDV)$$
   $$m = 1 + 9/98 \times (100 - HDV)$$
   $$m = 9{,}4$$

   Each of the deduct value is minus by m. But, if there is a DV value that is less than the value of m, no deduction is made. All DV values can be used if the result is DV – m < m.

5. Calculating of Total Deduct Value
   The TDV is obtained from the sum of all deduct values for each type of damage on one segment of the road. We need to know the q value before totalizing the DV. Where the q value is the deduct value that exceeds 2. After that, iteration is carried out until you get the value q = 1.

JICE Journal Innovation of Civil Engineering
Vol. 5, No. 1, pp. 24-33, 2024
Submit: 24-02-2024 |
Accepted: 04-05-2024 |
Publish: 16-05-2024 |

Table 3. Deduct Value Iteration

Deduct Value Iteration			**TDV**	**q**
8	8	3	19	3
8	8	2	18	2
8	2	2	12	1

6. Determining the CDV Value
   The way to determine the CDV is by the curve of correlation between TDV and q. The TDV value is drawn vertically until it intersects with the line of q, after which it is drawn horizontally to the left in the direction of the CDV value. It can be seen in images 4, 5, and 6 that the CDV values at STA 0+000 until 0+100 are 9, 12, and 12.

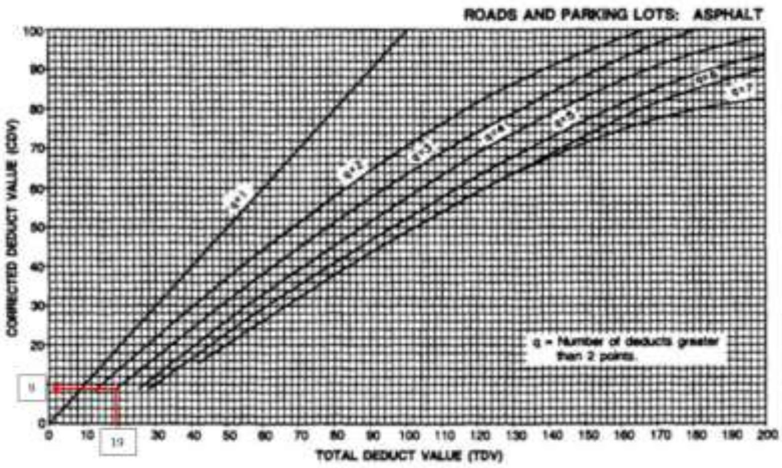

Figure 4. Correlation curve between CDV and TDV

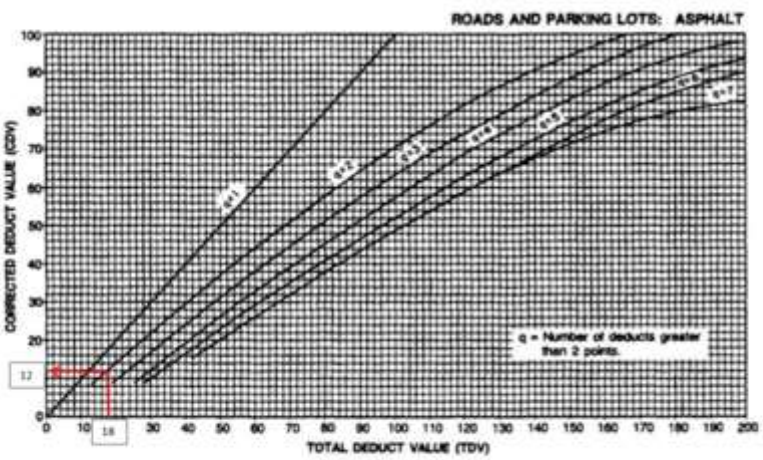

Figure 5. Correlation curve between CDV and TDV

JICE Journal Innovation of Civil Engineering
Vol. 5, No. 1, pp. 24-33, 2024
Submit: 24-02-2024 |
Accepted: 04-05-2024 |
Publish: 16-05-2024 |

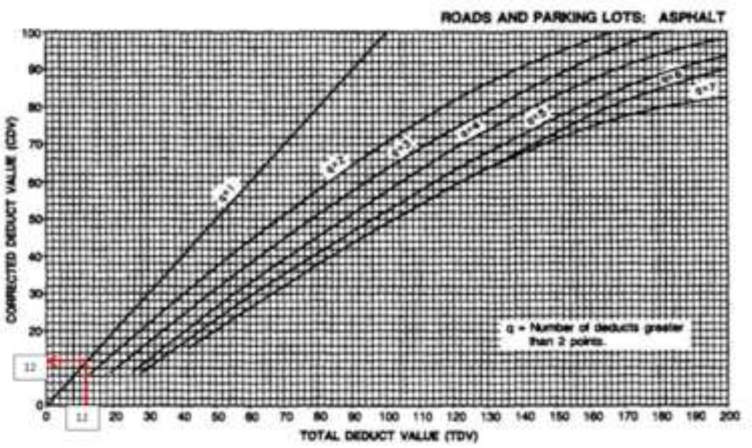

Figure 6. Correlation curve between CDV and TDV

7. Determination of PCI Value
   If the CDV value has been determined then the next step is to calculate the PCI value using the formula:
   PCI = 100 – CDV max

Table 4. Recapitulation of CDV Value Segment 1

Deduct Value Iteration			TDV	q	CDV
8	8	3	19	3	9
8	8	2	18	2	12
8	2	2	12	1	12

CDV *max* value in segment 1 is 12. So the PCI value obtained is as follows:

PCI = 100 – CDV *max*
= 100 – 12
= 88

In STA 0+000 until 0+100 (segment 1) the PCI value obtained is 88, which means it is included in the category Excellent.

Table 5. Recapitulation of Every PCI Value

Segment	STA	PCI	Rating
1	0+000 - 0+100	88	Excellent
2	0+100 - 0+200	80	Very Good
3	0+200 - 0+300	77	Very Good
4	0+300 - 0+400	65	Good
5	0+400 - 0+500	71	Fair
6	0+500 - 0+600	47	Fair
7	0+600 - 0+700	57	Very Good
8	0+700 - 0+800	62	Good
9	0+800- 0+900	72	Very Good
10	0+900 - 1+000	21	Very Poor
11	1+000 - 1+100	60	Poor

JICE Journal Innovation of Civil Engineering

Vol. 5, No. 1, pp. 24-33, 2024
Submit: 24-02-2024 |
Accepted: 04-05-2024 |
Publish: 16-05-2024 |

Segment	STA	PCI	Rating
12	1+100 - 1+200	70	Good
13	1+200 - 1+300	71	Good
14	1+300 - 1+400	70	Very Good
15	1+400 - 1+500	47	Failed
16	1+500 - 1+600	60	Good
Total of PCI Value		1018	Good
Average PCI Value		63,6	

Based on the table of PCI value analysis results above as a whole, an average PCI value of 63,6 was obtained which shows that the road is in the good category. It can be concluded that for Jelidro II – Kuwukan - Sambikerep roads with a road length of 1.6 kilometers the type of treatment required is routine maintenance.

3.2. Bina Marga Analysis Method

Analysis of road damage using the Bina Marga Method requires an Average Daily Traffic (LHR) survey and also a survey of road conditions in the study location. The LHR survey was carried out for 3 days, on Sunday (11 June 2023), Monday (12 June 2023), and Tuesday (13 June 2023). The duration of the survey in a day is divided into three times which represent peak hours, morning 3 hours (06.00-09.00), afternoon 3 hours (11.00-14.00), and 3 hours at (15.00-18.00).

1. Determining Daily Traffic Class
   The results of the daily traffic volume analysis showed that the highest peak hour was Monday at 07.00-08.00, that is 1470,65 pcu/hour. This volume is included in the daily traffic category 500-2000 with a traffic class value of 4.
2. Road Damage
   The calculation of road damage is taken as an example calculation at STA 0+200 – 0+300.

Table 6. Survey of Bina Marga Method for Segment 3

STA	Type of Damage								
	Surface Roughness		Potholes	Patching	Cracking			Grade Depression	
	Type	L x W (m)			Tipe	L (m)	W (m)	L x W (m)	Depth (m)
0+200-0+300			0,37x0,15	18,99x1,2	Longitudinal	9,6	0,01	0,83x0,3	0,02
				2,6 x 1,96	Longitudinal	2,4	0,06	1,2 x 0,4	0,03
					Longitudinal	2,8	0,09		

Segment Area: 6,3 x 100 = 630 m^2

In segment 3 there are 4 types of damage, those are pothole (0.05m^2), patching (27.88 m^2), longitudinal crack (0.49 m^2), and grade depression (0.73 m^2). Once the area of each damage is known, the next step is to calculate the percentage of damage:

a. Potholes $= \frac{0,05}{630} \times 100\%$ = 0,01 %

b. Patching $= \frac{27,88}{630} \times 100\%$ = 4,43 %

c. Longitudinal Crack $= \frac{0,49}{630} \times 100\%$ = 0,08 %

Vol. 5, No. 1, pp. 24-33, 2024
Submit: 24-02-2024 |
Accepted: 04-05-2024 |
Publish: 16-05-2024 |

3. Damage Grade

Table 7. Segment 3 Damage Grade

STA	Type of Damage	Grade				Grade Damage
		Type	Wide	Area	Depth	
0+200 - 0+300	Potholes			0		0
	Patching			0		0
	Longitudinal Crack	2	3	1		6
	Grade Depression				4	4
Total Damage Grade						10

4. Sequence of Priority

The total damage number for segment 3 is 10, so the condition value for that segment is 4. To find the priority order (UP), use the following formula:

UP = 17 – (LHR class + Damage Value)
= 17 – (4 + 4)
= 9

So, segment 3 requires a regular maintenance program.
This is a recap of the priority order for each segment and the type of maintenance.

Table 8. Recapitulation of Priority Order for Each Segment

No	STA	Damage Grade	Condition Value	UP	Maintenance Type
1	0+000 - 0+100	3	1	12	Routine Maintenance
2	0+100 - 0+200	9	3	10	Routine Maintenance
3	0+200 - 0+300	10	4	9	Routine Maintenance
4	0+300 - 0+400	18	6	7	Routine Maintenance
5	0+400 - 0+500	9	3	10	Routine Maintenance
6	0+500 - 0+600	6	2	11	Routine Maintenance
7	0+600 - 0+700	10	4	9	Routine Maintenance
8	0+700 - 0+800	10	4	9	Routine Maintenance
9	0+800 - 0+900	15	5	8	Routine Maintenance
10	0+900 - 1+000	15	5	8	Routine Maintenance
11	1+000 - 1+100	16	6	7	Routine Maintenance
12	1+100 - 1+200	6	2	11	Routine Maintenance
13	1+200 - 1+300	19	7	6	Periodic Maintenance
14	1+300 - 1+400	15	5	8	Routine Maintenance
15	1+400 - 1+500	19	7	6	Periodic Maintenance
16	1+500 - 1+600	15	5	8	Routine Maintenance
Total Damage Grade		195			Routine Maintenance
Average Damage Grade		12	4	9	

As can be seen from the table above, the total damage grade is 195. The average damage number was 12, which means it has a condition value of 4. It can be

Vol. 5, No. 1, pp. 24-33, 2024
Submit: 24-02-2024 |
Accepted: 04-05-2024 |
Publish: 16-05-2024 |

concluded that the average priority order for the Jelidro II – Kuwukan - Sambikerep roads section is 9, the type of treatment on this section is a routine maintenance program. In Table 8 also, segment 3 shows a priority damage level of 9, indicating the need for routine maintenance. This is supported by the results of the Average Daily Traffic (LHR) survey for the segment, which influences the condition value and UP.

4. Conclusion

On the Jelidro II – Kuwukan – Sambikerep roads along 1,6 km, there were several types of damage with a total area of 240,60 m^2. The damage that occurred included crocodile skin cracks of 38,40 m^2 (15,96%), grade depression with an area of 6,27 m^2 (2,61%), edge cracks with an area of 23,31 m^2 (9,69%), potholes with an area of 4,96 m^2 (2,06%), patching with an area of 146,96 m^2 (61,08%), longitudinal cracks with an area of 12,41 m^2 (5,16%), slip cracks with an area of 0,04 m^2 (0,02%), and raveling with an area of 8,25 m^2 (3,43%). The results of the analysis of the level of road damage using the Pavement Condition Index method show a PCI value of 63,6 which is included in the good category. In the Bina Marga method, a priority order is 9.

For each road condition value, the PCI method and the Bina Marga method have the same type of treatment, which is a routine maintenance program. The repairs carried out are surface layers such as asphalt resurfacing and patching holes. This study showed that both methods provide similar maintenance recommendations, albeit with different calculation approaches. This research offers empirical evidence that combining the two methods can enhance the accuracy of road condition evaluations. Future research could explore the combination of the PCI and Bina Marga methods on roads with different characteristics, such as class I roads or highways. Furthermore, studies using technology-based approaches like remote sensing could expedite the process of collecting road damage data.

References

[1] "Undang-Undang No. 22 Tahun 2009 tentang Lalu Lintas dan Angkutan Jalan," Pemerintah Republik Indonesia, Jakarta, Indonesia, 2009.

[2] Asriani, Sulfanita, and Andriyani, "Analisa kerusakan lapis perkerasan lentur jalan menggunakan metode Pavement Condition Index (PCI): Studi kasus Jalan Salokarajae Desa Pattondon Salu Kecamatan Maiwa Kabupaten Enrekang," *Jurnal Karajata Engineering*, vol. 2, no. 2, pp. 78–86, 2022. [Online]. Available: http://jurnal.umpar.ac.id/index.php/karajataASTM

[3] ASTM Standard D 6433-07, "Standard practice for roads and parking lots pavement condition index survey," ASTM International, USA, 2007.

[4] Direktorat Jenderal Bina Marga, "Tata cara penyusunan program pemeliharaan jalan (018/T/Bnkt/1990)," Direktorat Jenderal Bina Marga, Indonesia, 1990.

[5] Direktorat Jenderal Bina Marga, "Manual Pemeliharaan Rutin untuk Jalan Nasional dan Jalan Provinsi, Jilid II: Metode Perbaikan Standar", Departemen Pekerjaan Umum Republik Indonesia, Jakarta, Indonesia, 1995.

[6] Direktorat Jenderal Bina Marga, "Pedoman Kapasitas Jalan Indonesia", No. 09/P/BM/2023, p. 353, 2023.

[7] R. Faisal, Zulfhazli, A. A. Hakim, and Muchtaruddin, "Perbandingan metode Bina Marga dan metode PCI (Pavement Condition Index) dalam mengevaluasi kondisi kerusakan jalan (Studi kasus Jalan Tengku Chik Ba Kurma, Aceh)," *Teras Jurnal*, vol. 10, no. 1, pp. 110–122, 2020, doi: 10.29103/tj.v10i1.256.

[8] A. D. Fatikasari, "Analisa tingkat kerusakan jalan menggunakan metode PCI untuk mengevaluasi kondisi jalan di Raya Cangkringan, Kecamatan Krembung, Kabupaten Sidoarjo," *Agregat*, vol. 6, no. 2, 2021.

Vol. 5, No. 1, pp. 24-33, 2024
Submit: 24-02-2024 |
Accepted: 04-05-2024 |
Publish: 16-05-2024 |

[9] R. Handayani and A. F. Wicaksono, “Road Thickness Analysis Using MDP Method 2017 (Case: Purwodadi – Nongkojajar).” *Journal Innovation of Civil Engineering* (JICE). (2)2, 96-103, 2021.

[10] O. J. Hendra, V. T. Haris, and H. Rahmat, "Analisis kerusakan perkerasan jalan menurut Bina Marga dan alternatif penanganannya (Studi kasus ruas Jalan Utama Bunsur-Mengkapan)," *Jurnal Teknik*, vol. 16, no. 1, pp. 58–66, 2022.

[11] E. W. Junior, L. W. H. Leba, and S. S. L. M. F. Seran, "Analisis kerusakan jalan menggunakan metode Asphalt Institute: Studi kasus Jl. Claret Sta 0–Sta 800," *Local Engineering*, vol. 1, no. 1, pp. 32–34, 2023, doi: 10.59810/localengineering.

[12] T. Kurrahman, "Analisa kerusakan jalan berdasarkan metode Bina Marga (Studi kasus Jalan Mangliawan – Tumpang Kabupaten Malang)," *Jurnal Ilmu-Ilmu Teknik-Sistem*, vol. 17, no. 1, pp. 45–53, 2021, doi: 10.37303/sistem.v17i1.206.

[13] A. Ma’ruf and Firdaus, "Analisis kerusakan di Jalan Mangku Bumi dengan metode PCI (Pavement Condition Index) (Studi kasus Jalan Mangku Bumi Palembang)," *Bina Darma Conference on Engineering Science*, vol. 4, no. 2, pp. 240–252, 2022.

[14] H. Melinda, M. Sebayang, and S. Djuniati, "Evaluasi kondisi kerusakan permukaan jalan dengan menggunakan metode Pavement Condition Index (PCI) (Studi kasus: Jalan Riau Ujung Pekanbaru)," *JOM FTEKNIK*, 2020.

[15] E. R. Navita, "Evaluasi tingkat kerusakan Jalan Tanjung Sari dengan metode Pavement Condition Index (PCI) dan metode Bina Marga," Tugas Akhir, Prodi Teknik Sipil dan Perencanaan, ITATS, Surabaya, Indonesia, 2020.

[16] C. H. Oglesby, *Teknik Jalan Raya, Jilid 1*, Jakarta: Gramedia, 1999.

[17] K. H. Putra, I. S. Ingsih, and R. Firmansyah, "Rigid pavement design for the Jawar Road Surabaya City with Manual Design of Road Pavement 2017," *Journal Innovation of Civil Engineering (JICE)*, vol. 3, no. 1, pp. 44–51, 2022.

[18] R. Santosa, B. Sujatmiko, and F. A. Krisna, "Analisis kerusakan jalan menggunakan metode PCI dan metode Bina Marga (Studi kasus Jalan Ahmad Yani Kecamatan Kapas Kabupaten Bojonegoro)," *Ge-STRAM: Jurnal Perencanaan dan Rekayasa Sipil*, vol. 4, no. 2, pp. 104–111, 2021. [Online]. Available: https://ejournal.unitomo.ac.id/index.php/gestram/article/view/4196/2062

[19] D. Setiawan and H. Suprapto, "Penentuan metode pemeliharaan dan penanganan lapis permukaan lentur jalan menggunakan metode Pavement Condition Index (PCI)," *Syntax Literate: Jurnal Ilmiah Indonesia*, vol. 6, no. 1, pp. 50–66, 2021.

[20] M. Y. Shahin, *Pavement Management for Airport, Roads, and Parking Lots*, New York: Chapman & Hall, 1994.

[21] S. Sukirman, *Perkerasan Lentur Jalan Raya*, Bandung: Nova, 1993.

[22] "Undang-Undang Republik Indonesia No. 38 Tahun 2004 tentang Jalan," Pemerintah Republik Indonesia, Jakarta, Indonesia, 2004.