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ANALYSIS OF ROAD DAMAGE USING THE PAVEMENT CONDITION INDEX METHOD ON THE LAMONGAN CITY – MOJOKERTO BORDER ROAD SECTION

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Abstract

Road as an important facility for the community to achieve a desired goal both mobilizing goods and services. On the Lamongan City – Mojokerto border road section STA 20+000 - 26+000 based on the field has experienced a decrease in road services that are not stable / comfortable with a lot of damage to the road. This study aims to determine how much the pavement performance index is with the Pavement Condition Index (PCI) method, determine the handling of road maintenance and the cost of handling road maintenance based on the two methods. From the research results, the value of the pavement performance index based on the Pavement Condition Index (PCI) method is 72.1%, this is in the good category and includes a periodic maintenance handling program, the cost of handling road maintenance with the Pavement Condition Index (PCI) method is Rp. 15,614,599,505.96.

Keywords: *Road Damage, Pavement Condition Index (PCI) Method, Road Section*

1. INTRODUCTION

Government Regulation of the Republic of Indonesia No. 38 of 2004 on Roads states that roads have an important role in realizing the development of the nation's life. Therefore, roads are needed by the community in carrying out their daily activities. Therefore, roads need to be evaluated periodically so that the level of service can be maintained (Kusmaryono & Sepinggan, 2020). The highway is an important facility for the community in order to achieve a desired goal of mobilizing goods and services (Lasarus et al., 2020; Purnomo & Putra, 2022). For this reason, people need roads that are safe and comfortable for their users, in order to achieve stable road criteria, there are technical provisions that must be met by a road section so that the road can function optimally to meet Minimum Road Service Standards in serving road users in traffic and transportation activities.

Based on their status, roads are divided into national roads, provincial roads and district roads. National roads are roads organized by the central government consisting of primary arterial roads, primary collector roads. Provincial roads are roads organized by the provincial government consisting of primary collector roads, primary collector roads and provincial strategic roads. Regency roads are roads organized by the regency government consisting of primary collector roads that do not include national roads and provincial roads. The type of road structure is flexible pavement and rigid pavement, the road has a road service life which can be maintained by road maintenance so that it can reach the planned road service life. Road conditions that often receive heavy and repetitive traffic can degrade the performance of the road surface, which can increase the risk of accidents and reduce the comfort of road users (T. Triyanto et al., 2019).

Pavement condition is an important aspect in terms of determining road maintenance and repair activities. to assess the condition of the pavement, it is necessary to first determine the type of damage, the cause, and the level of damage that occurs (A. I. Triyanto, 2021). In general, road damage is caused by several reasons, namely the age of the road plan that has been passed, puddles of water on the road surface that cannot flow due to poor drainage, soft soil structure, repeated overloaded traffic loads that cause the life of the road to be shorter than planning (Yuliandra et al., 2022). The impact of traffic can cause negative problems, the increasing need for mobility affects the demand for increased vehicle use (Harfa et al., 2023). The increase in vehicle mass reduces the quality and life of the road structure as the load exceeds the planned road class limit.

Broadly speaking, road damage can be divided into two parts, namely structural damage and functional damage. The types of structural damage consist of cracking, deformation, surface defects, wear and tear, cracking, and settlement of utility plantings (Delfina et al., 2023). Functional damage types usually include roughness and deflection that cause discomfort to road users. Road damage includes potholes, alligator cracks, bleeding / fatness, block cracks, cracking, subsidence, edge cracks, longitudinal grooves and longitudinal / transverse cracks (Yunardhi, 2019). However, over time the road performance will experience a decrease in condition in accordance with the increasing age of the road, resulting in an obstacle in the smooth running of a trip. Road conditions whose function has decreased so that it does not get worse, it is necessary to carry out road maintenance so that the road function increases again so that it becomes a steady road that is comfortable for road users (Faisal, 2020). To keep the road condition in proper performance in serving various modes of transportation, it is necessary to evaluate the road surface to find out whether the road is still in good condition or needs an improvement program, routine maintenance or periodic maintenance.

Routine Maintenance is road asset maintenance work that is carried out annually (Setiawan & Lestarini, 2022). Routine maintenance work can be grouped as cyclical work, work that has a certain frequency in maintenance standards, such as cutting vegetation, cleaning channels, and culverts. Routine maintenance work can also be categorized as reactive work, Determining the type and timing of work based on the level of intervention (specified in the maintenance standard), for required maintenance. Example: patching work is done when a pothole is observed. Routine maintenance can also use mechanical/thin preventive treatments that can be carried out according to local conditions, including asphalt rejuvenation (binder rejuvenation: fog seal), crack sealing, crack filling, burda/burtu (spray bitumen chip seal), spray bitumen sand seal, Latasir (sand sheet), emulsified asphalt slurry (emulsified asphalt slurry seal).

Lamongan City – Mojokerto Border road section is a road with a flexible pavement structure and based on its function includes a primary collector road which connects efficiently between national activity centers with the activity centers of Lamongan Regency and Mojokerto Regency, between regional activity centers with the activity center of Lamongan Regency. Making community activities in the region have a high level of mobility, productivity and economic activity. In the section, the mobility of cargo cars is very high because there is excavation C where the load exceeds the standard capacity, resulting in a load that is supported by the road body is very heavy so that it can cause a shorter road service life. Based on its status, the Lamongan City – Mojokerto Border road section is a provincial road which as the organizer / has the authority is the East Java provincial government represented by the East Java Bina Marga Public Works Office.

The road section of Lamongan City – Mojokerto Border was STA 20+000-26+000 based on the field has experienced a decrease in road services that have become unstable / comfortable with a lot of damage to the road, so that it can endanger road users, slow down the mobility of road users and have an impact on the economy of the surrounding area. Given the importance of this road that connects between the centers of economic activity of the district, East Java province and the National. So, it is necessary to analyze the value of the road damage index as a rare one of the stages to determine the type of road maintenance evaluation program that needs to be carried out. Road damage index analysis can use two methods, namely the Pavement Condition Index (PCI) method. The results of the assessment of the condition of the road surface damage that has been determined visually analyzed by both methods can be made a reference in handling road maintenance so that the road can be stable and comfortable for road users.

In accordance with the subject matter, the objectives to be achieved are as follows. First, identify the pavement performance index based on the Pavement Condition Index (PCI) method that occurs on the Lamongan City – Mojokerto Border road section STA 20+000-26+000. Second, determine the handling of the pavement performance index using the Pavement Condition Index (PCI) method. Third, calculate the cost of handling road maintenance with the Pavement Condition Index (PCI) method.

2. RESEARCH METHOD

2.1. Research Location

The location of this research was carried out on the provincial road Lamongan City – Mojokerto Border road section link 106 at STA 20+000-26+000, the research was carried out by going to the location by visually seeing the condition of the road damage and the severity.

2.2. Data Collection Technique

In this data collection stage, there are 2 (two) types of data collected, as for the data - the data is as follows:

a. Primary Data

Primary data is data obtained by direct observation and measurement at the research location, the primary data required in this study are as follows:

a) Calculate the type of vehicle or class of vehicle that passes at a point on the road section of Lamongan City – Mojokerto Border was at STA 20+000 - 26+000.
b) Identify the type of road damage that exists on the Lamongan City – Mojokerto Border road section at STA 26+000 -26+000.
c) Measurement data of road damage (length, width)
d) Photo documentation of road damage.
e) STA of road damage point.

b. Secondary Data

Secondary data is data obtained through existing data sources, from related agencies, books, reports, journals or other relevant sources. The secondary data required in this study are as follows:

a) Secondary data in the form of research location sketches obtained from the internet (google map).
b) Data on the name of the road section, STA, length, road width, unit price data and maintenance handling methods are all from the East Java Bina Marga Public Works Office.

The method of collecting road damage data in the field is as follows:

a) Dividing the road into 30 segments from a total road length of 6 km, road width of 7 m. each segment is 200 m with a width of 7 m according to the width of the road.
b) Identify the types of road damage that exist in each segment.
c) Calculating and measuring the dimensions of damage for each type of damage in each segment.
d) Document each type of damage in each segment.
e) Identifying the class of vehicles passing at a point from 7:00 am to 7:00 pm for 2 days.

2.3. Research Instrument

Some of the instruments used in this study are:

a. A road damage survey form or tool that can record at least the following information: date, location, segment, section, sample unit size, number and size of panels, type, severity, and quantity of damage.
b. A traffic enumeration survey form can be found in the appendix table that can record at least the information on the class of vehicles passing and the number of vehicles passing.
c. Hand-held tally counter.
d. Wheeled meter that can measure distance.
e. Mistar.
f. Network map for the road network to be surveyed.
g. Digital camera.

2.4. Data Analysis Technique

Researchers calculated the data obtained through survey results in the field with the Pavement Condition Index (PCI) method, as for the steps for analyzing road condition data with the Pavement Condition Index (PCI) method are:

a. Calculating Density
b. Determine the DV (Deduct Value) by correlating the damage type graph between density and severity.
c. Determining the Total Deduct Value.
d. Determining the Corrected Deduct Value*)*

a) Determine the number of deduct values greater than 2 (q).
b) Determine the total deduct value by summing up each deduct value.
c) Determine the CDV from calculations a) and b) using the deduct value correction curve,
d) The smallest deduct value is subtracted against 2.0 then repeat steps a) through until obtaining a value of q = 1.
e) The maximum CDV is the largest CDV in the iteration process above

e. Calculating Pavement Condition Score Using PCI Method
f. Determine the handling of the pavement condition value

2.5. Data Analysis

Data was obtained from direct visual surveys in the field by recording and measuring the dimensions of road damage on the road damage form and recording the traffic volume of the type of vehicle class passing by on the traffic enumeration form.

3. RESULT AND DISCUSSION

3.1. Identification of Road Damage Types

From the results of the survey in the field, researchers obtained the types of pavement damage found at the research location by identifying the condition of road damage and measurements for each type of damage in each segment, which there are 30 segments, the following types of damage are presented at the research location and the damage code in table 1.

Table 1. Road Damage Types and Codes

KODE KERUSAKAN						
111 LUBANG - LUBANG	112 BERGELOMBANG	114 AMBLES	115 JEMBUL	117 RETAK BUAYA	118 RETAK MEMANJANG	120 TERKELUPAS

Source: Processed by Researcher, 2024

In table 1, reveal road damage types and codes which categorizes various forms of road damage with corresponding numeric codes. The damage types, listed in Indonesian, include 111 - *LUBANG LUBANG* (Potholes) 112 - *BERGELOMBANG* (Corrugation or Wavy surface) 114 - *AMBLES* (Rutting or Sinking) 115 - *JEMBUL* (Depression or Bumps) 117 - *RETAK BUAYA* (Alligator cracking) 118 - *RETAK MEMANJANG* (Longitudinal cracking) 120 - *TERKELUPAS* (Raveling or Surface peeling) Giving a code to each type of damage makes it easier to record in the survey form and the following are the results of the road damage survey on Segment 1 STA 20+000-20+ 200 and Segment 2 STA 20+200 -20+400 in table 2.

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Table 2. Road Damage Survey Results

No	KM Lngan			POSISI			Kategori Kerusakan *)	UKURAN RATA - RATA **)				Tingkat kerusakan
				Ki	Cl	Kn		P (m')	L (m')	D (m')	A (m^2)	
(1)	(2)			(3)			(4)	(5)	(6)	(7)	8) = (5) x (6	(11)
	SEGMEN 1											
1	20 + 050	-	20 + 056	-	-	√	120	6,00	4,00	0,03	24,00	Sedang
2	20 + 150	-	20 + 154	-	-	√	117	3,80	1,80	-	6,84	Rendah
3	20 + 180	-	20 + 183	-	√	-	114	2,80	1,10	0,03	3,08	Sedang
	SEGMEN 2											
4	20 + 220	-	20 + 223	-	-	√	117	2,50	1,60	-	4,00	Sedang
5	20 + 290	-	20 + 295	-	-	√	120	4,50	2,00	0,05	9,00	Sedang
6	20 + 315	-	20 + 317	-	-	√	114	1,80	1,80	0,03	3,24	Sedang
7	20 + 370	-	20 + 373	√	-	-	117	3,30	2,00	-	6,60	Sedang

Source: Processed by Researcher, 2024

Table 2 above explains that in segment 1 there are 3 types of road damage, namely Aggregate peeling at STA 20 + 050 with a length of 6 m, width 4 m into 4 cm of damage with moderate severity. Crocodile cracks at STA 20 + 150 with a length of 3.8 m, width of 1.8 m and damage area of 6.84 m^2 with low severity and collapse damage at STA 20 + 180 length of 2.8 m, width of 1.1 m, depth of 3 cm and damage area of 3, 08 m^2 with moderate severity.

In segment 2 there are 4 road damages, namely crocodile cracks at STA 20 + 220 with a length of 2.5 m, width of 1.6 m and an area of 4 m^2 with moderate severity, peeling aggregate at STA 20 + 290 with a length of 4.5 m, width of 2 m, depth of 4 cm and an area of 9 m^2 with moderate severity, Ambles at STA 20+315 length 1.8 m width 1.8, depth 3 cm and area 3.24 m^2 with moderate severity and crocodile cracks at STA 20+370 length 3.3 m, width 2m and area 6.6 m^2 with moderate severity. From the results of recording the class of vehicles and the number of vehicles passing through the traffic enumeration form, the peak traffic volume at certain hours can be seen in table 3.

Table 3. Peak Traffic Volume

Day	Hours	MC	LV	HV
1st Morning	07.00 -08.00	1200	810	206
1st Evening	16.00-17.00	1100	723	175
2nd Morning	07.00 -08.00	1100	797	208
2nd Evening	16.00-17.00	990	742	225
number (vehicles/hour)		4390	3072	814
total (smp/hour)		2195	3072	1058,2

Source: Processed by Researcher, 2024

The table above explains that on the first day the peak hour of traffic volume at 07.00 -08.00 WIB, for 2-wheeled or three-wheeled vehicles (MC) as many as 1200 vehicles / hour, for light vehicles (LV) as many as 810 vehicles / hour and for heavy vehicles as many as 206 vehicles / hour. For day 2 the peak traffic volume is also the same at 07.00 - 08.00 WIB.

3.2. Pavement Condition Index Method (Pavement Conditional Index/PCI)

Using the PCI method by dividing the road segment into 30 segments. The next step is to calculate the PCI value for each segment The following will present how to determine the PCI value:

a. Provide road defect level values through the survey in table 2.
b. Calculate the regularity of damage (density)
a) Segment 1 STA 20+000 - 20+200 chipped aggregate damage area24 m^2

Area of alligator crack damage = 6.84 m^2.
Area of subsidence damage = 3.08 m^2.

The damage density of chipped aggregates with the equation of formula 2.6 amounted to 1.71%. The damage density of crocodile cracks with equation 2.6 is 0.49%. The damage density (density) of collapse with the equation of formula 2.6 amounted to 0.22%.

b) Segment 2 STA 20+200-20+400 crocodile crack damage area of 10.6 m^2. The area of chipped aggregate damage amounted to 9 m^2.

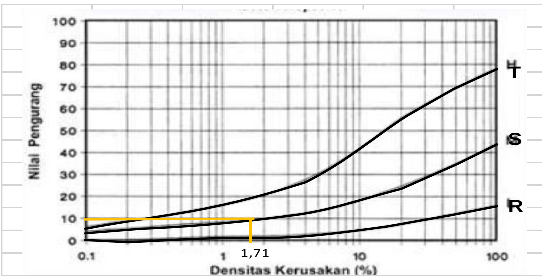
Extent of subsidence damage = 3,24 m^2.

The damage density of crocodile cracks with the equation of formula 2.6 is 0.76%. The damage density of chipped aggregate with the equation of formula 2.6 amounted to 0.64%. The damage density of ambels amounted to 0.23%.

3.3. Determining the Deduct Value (DV)

By connecting the graph of the type of damage between density and severity in each segment, the method is to enter the density value into the deduct value graph by drawing a vertical line on the deduct value until it intersects the T, S, and R lines and then draw a horizontal line. Determine the deduction value of segment 1 and segment 2 as follows:

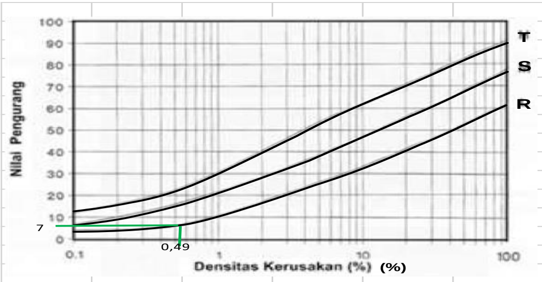
a. Segment 1 has a known aggregate chipping damage density value of 1.71%, alligator cracking of 0.49%. And subsidence amounted to 0.22%. The relationship between the damage graph and the damage density of chipped aggregate is shown in Figure 1.



Source: Processed by Researchers, 2024

Figure 1. Reduction Value of Medium Severity Chipped Aggregate

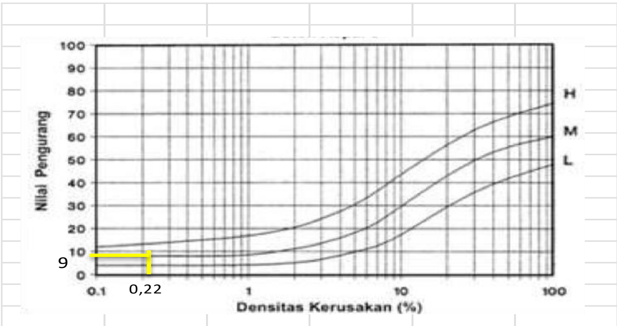
In Figure 1 above, the result of the relationship between the damage density of 1.171% and the chipped aggregate damage graph results in a deduct value of 10.



Source: Processed by Researchers, 2024

Figure 2. Reduction Value of Low Severity Alligator Cracks

In Figure 2, the results of the 0.49% crocodile crack damage density relationship are drawn vertically until they intersect the crack severity line (R) and then a horizontal line is drawn to determine the deduct value of 7.

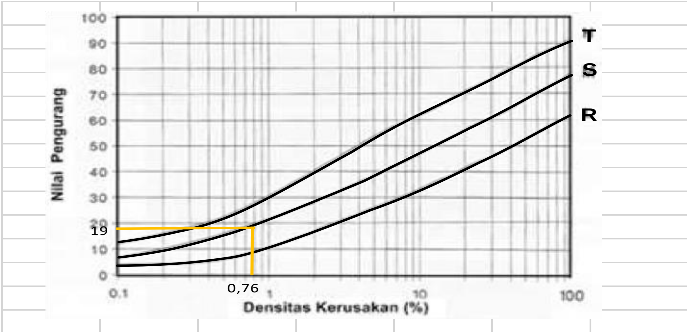


Source: Processed by Researcher, 2024

Figure 3. Deduct Value for Ambles of Medium Severity

In Figure 3, the results of the 0.22% subsidence damage density relationship are drawn vertically until it intersects the medium graph (M) after which it is drawn horizontally until it determines the deduct value of 9.

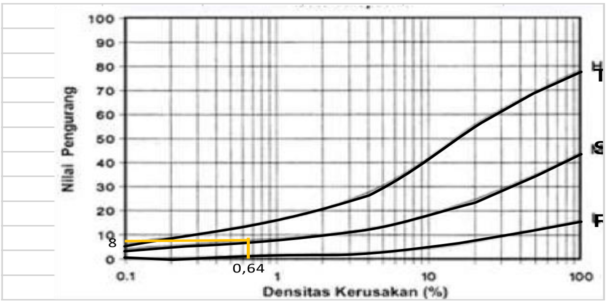
b. Segment 2 known damage density value (density) crocodile cracking medium severity of 0.76%, aggregate peeling medium severity of 0.64% and subsidence medium severity of 0.23%. To determine the damage reduction value of medium severity alligator cracking can be seen in Figure 4.



Source: Processed by Researchers, 2024

Figure 4. Deduct Value of Medium Severity Alligator Cracks

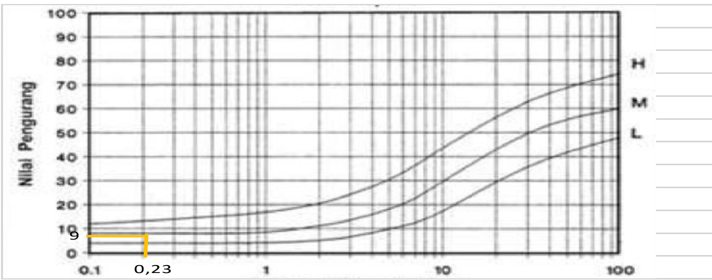
In Figure 4 above, the density value of 0.76% is drawn vertically until it intersects the medium severity line (S) and then drawn horizontally to determine the deduction value of 19.



Source: Processed by Researcher, 2024

Figure 5. Deduct Value of Medium Severity Chipped Aggregate

In Figure 5, the medium severity chipped aggregate density of 0.64% is drawn vertically until it intersects the medium severity line (S) and then horizontally until it determines the dedut value of 8.



Source: Processed by Researcher, 2024

Figure 6. Deduct Value of Ambles of Medium Severity

In Figure 6 above, the density value of moderate severity damage of 0.23% is pulled vertically until it intersects the moderate severity line (M) and then drawn horizontally to determine the deduct value of 9.

Table 4. Density Value and Deduct Value

Segmen	Kataagori Kerusakan	Total Keruskan m2	Tingkat Kerusakan	Density (%)	Deduct Value
1	117	6,84	rendah	0,49	7
	120	24,00	sedang	1,71	10
	114	3,08	sedang	0,22	9
2	117	10,60	sedang	0,76	19
	120	9,00	sedang	0,64	8
	114	3,24	sedang	0,23	9
3	117	27,46	rendah	1,96	13
	111	1,00	rendah	0,07	5
4	117	12,30	rendah	0,88	9
	114	22,86	sedang	1,63	10
	112	13,20	sedang	0,94	8
5	114	11,50	Sedang	0,82	9
	114	7,20	Tinggi	0,51	11
	120	6,00	Sedang	0,43	9
	117	14,70	Sedang	1,05	21
6	111	2,00	rendah	0,14	28
	112	7,50	rendah	0,54	0,1
	114	21,66	sedang	1,55	10
	117	7,68	sedang	0,55	25
7	111	3,00	Rendah	0,21	30
	114	33,50	sedang	2,39	11
	114	30,00	tinggi	2,14	20
	112	19,09	Rendah	1,36	3
8	111	1,00	sedang	0,07	29
	114	4,00	sedang	0,29	9
	120	3,60	sedang	0,26	6
Segmen	Kataagori Kerusakan	Total Keruskan m2	Tingkat Kerusakan	Density (%)	Deduct Value
9	111	2,00	Rendah	0,14	24
	114	19,95	Sedang	1,43	10
	115	3,20	Sedang	0,23	4
10	111	3,00	Rendah	0,21	30
	114	45,34	rendah	3,24	15
	114	30,00	Tinggi	2,14	20
11	111	3,00	Rendah	0,21	30
	114	53,09	Sedang	3,79	18
	117	4,05	Rendah	0,29	3
12	111	4,00	Rendah	0,29	35
	114	26,20	Rendah	1,87	10
	117	3,40	Rendah	0,24	4
13	111	1,00	Rendah	0,07	5
	114	37,00	Sedang	2,64	11
	117	4,00	Rendah	0,29	4
	120	11,80	Sedang	0,84	8
14	111	4,00	Rendah	0,29	38
	114	30,50	Sedang	2,18	11
	117	8,00	Sedang	0,57	18
15	111	2,00	Rendah	0,14	28
	1 12	12,00	Sedang	0,86	14
	114	8,00	Sedang	0,57	9
	117	14,00	Sedang	1,00	10
	120	22,40	Sedang	1,60	10
16	111	2,00	Rendah	0,14	28
	114	32,50	Sedang	2,32	11
	117	16,80	rendah	1,20	22
	120	12,40	Sedang	0,89	8
17	111	4,00	Rendah	0,29	38
	114	16,00	Sedang	1,14	9
	117	6,00	Sedang	0,43	12
	120	4,00	Sedang	0,29	9
18	111	3,00	Rendah	0,21	30
	114	22,50	Rendah	1,61	4
	117	10,00	Sedang	0,71	19
	120	14,00	Sedang	1,00	9

Segmen	Kataagori Kerusakan	Total Keruskan m2	Tingkat Kerusakan	Density (%)	Deduct Value
19	111	1,00	Rendah	0,07	18
	114	51,50	Sedang	3,68	11
	117	24,00	Sedang	1,71	20
20	111	1,00	Rendah	0,07	18
	114	45,00	Sedang	3,21	15
	117	34,00	Rendah	2,43	10
21	111	2,00	Rendah	0,14	28
	112	20,00	rendah	1,43	19
	114	30,50	Sedang	2,18	4
	115	1,50	Rendah	0,11	1
	117	24,00	rendah	1,71	13
	120	16,20	rendah	1,16	0
22	111	3,00	Rendah	0,21	30
	114	24,00	Sedang	1,71	10
	115	2,00	Sedang	0,14	10
	117	12,00	Rendah	0,86	10
23	118	16,00	Rendah	1,14	3
	114	35,00	Rendah	2,50	8
	120	4,00	Sedang	0,29	8
24	118	8,00	Rendah	0,57	0
	112	15,00	Rendah	1,07	5
	114	21,00	Sedang	1,50	10
	115	4,80	Sedang	0,34	15
	117	36,00	Rendah	2,57	18
25	118	5,50	Sedang	0,39	4
	111	1,00	rendah	0,07	18
	114	45,20	Rendah	3,23	8
	117	20,00	Rendah	1,43	12
Segmen	Kataagori Kerusakan	Total Keruskan m2	Tingkat Kerusakan	Density (%)	Deduct Value
26	118	7,00	Sedang	0,50	5
	117	40,00	Rendah	2,86	20
27	118	8,00	Rendah	0,57	0
	114	18,00	Rendah	1,29	5
	118	6,00	sedang	0,43	2
28	118	8,00	sedang	0,57	5
	114	5,00	Rendah	0,36	3
	115	2,00	Rendah	0,14	10
	117	11,00	Rendah	0,79	9
	120	22,00	Rendah	1,57	0,7
29	118	15,00	Rendah	1,07	5
	114	26,00	Sedang	1,86	10
	117	26,00	rendah	1,86	12
30	118	21,00	Rendah	1,50	10
	114	11,90	Rendah	0,85	4
	116	6,00	Rendah	0,43	4
	117	14,00	Rendah	1,00	5
	120	16,00	Rendah	1,14	0,2

Source: Processed by Researcher, 2024

3.4. Calculating the maximum Corrected Deduct Value (CDV)

Calculate the corrected subtraction value (CDV) by iterating as follows:

a. List each deduct value segment in decreasing order.
b. Define q as the number of individual deductors greater than 2.
c. Reduce the smallest deduct value greater than 2 to 2 and repeat the steps until q=1.
d. Determine the maximum corrected subtractor value or maximum CDV by relating it to the total subtractor value graph.

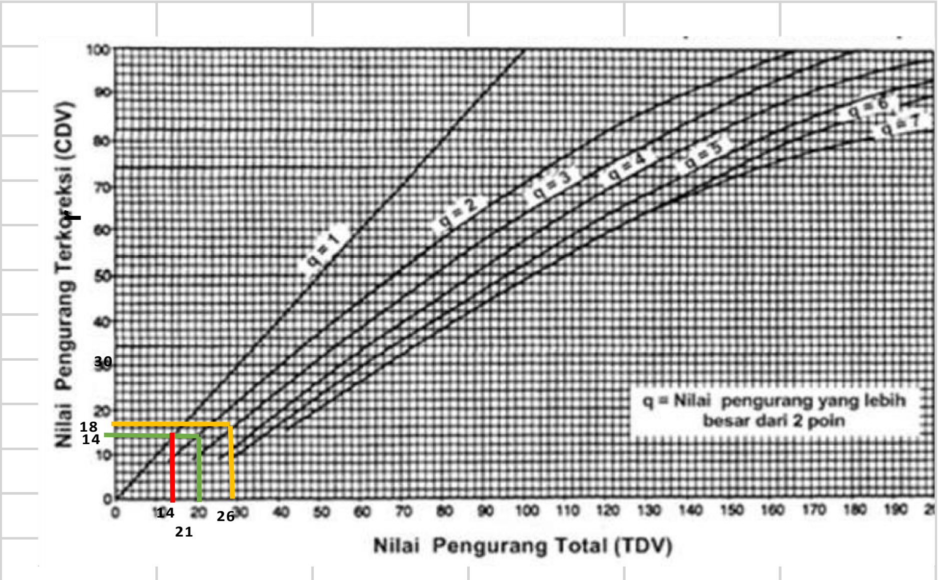
Calculated the maximum corrected reduction / maximum CDV of segment 1 with the following known that the deduct values of segment 1 from large to small are 10, 9 and 7. Reduce the deduct value to q = 1.

Table 5. Total Deduct Value (TDV) and Corrected Deduct Value (CDV)

Nilai Deduct Value dari Besar ke Kecil			TDV	q	CDV
10	9	7	26	3	18
10	9	2	21	2	14
10	2	2	14	1	14

Source: Processed by Researcher, 2024

In table 5, where it starts q = 3 with total deduct value (TDV) by adding up all the deduct value values 10. 9, 7 = 26, q = 2 with TDV adding up the deduct value 10, 9, 2 equals 21 where the smallest deduct value 7 is reduced to 2, q = 1 with TDV adding up the deduct value 10, 2, 2, equals 14 where the second smallest deduct value is 9 reduced to 2. For the CDV value, it can be obtained from the TDV graph relationship with the q value.



Source: Processed by Researchers, 2024

Figure 7. Corrected Reduction Value (CDV)

In Figure 7 the total deduction value of 14 is drawn horizontally in red until it intersects the q1 line then horizontally drawn in red until the corrected deduction value of 14, the total deduction value of 21 is drawn vertically in green until it intersects the q2 line then horizontally drawn until the corrected deduction value of 14, the total deduction value of 26 is drawn vertically in yellow until it intersects q3 then horizontally drawn until the corrected deduction value of 18. So the maximum corrected deduction value of segment 1 is the value of 18 with q equal to 3.

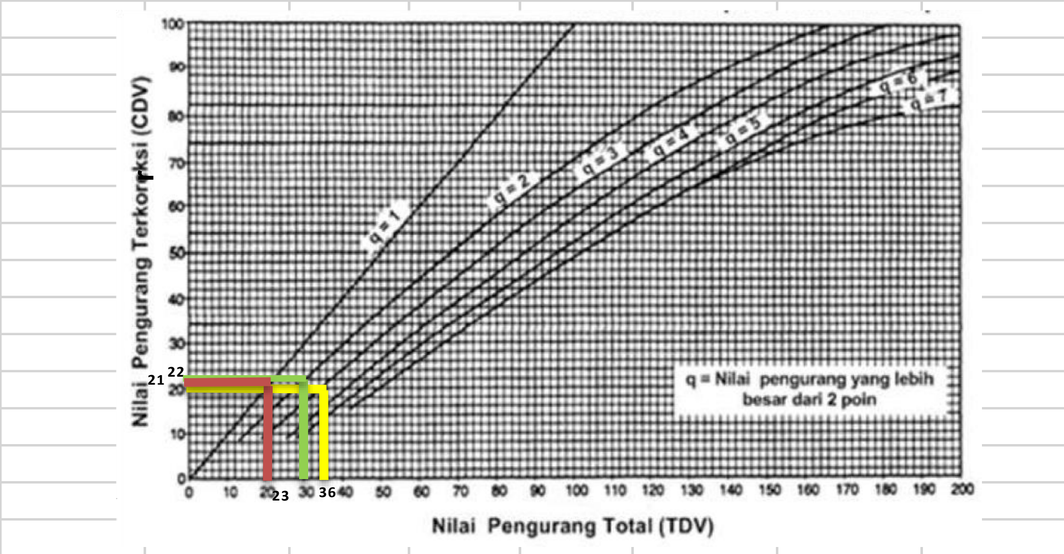
Calculating the maximum corrected deduct value / maximum CDV of segment 2, namely the deduct value of segment 1 from large to small is 19, 9 and 8. Then reduce the deduct value to q = 1 as in table 6.

Table 6. Total Deduct Value (TDV) and Corrected Deduct Value (CDV)

Nilai Deduct Value dari Besar ke Kecil			TDV	q	CDV
19	9	8	36	3	20
19	9	2	30	2	22
19	2	2	23	1	21

Source: Processed by Researcher, 2024

In table 6 above where it starts q = 3 with a total deduct value (TDV) by adding up all the deduct value values 19. 9, 8 = 36, q = 2 with TDV adding up the deduct value values 19, 9, 2 equal to 30 where the smallest deduct value value 8 is reduced to 2, q = 1 with TDV adding up the deduct value values 19, 2, 2, equal to 23 where the second smallest deduct value is 9 reduced to 2. For the CDV value, it can be obtained from the TDV graph relationship with the q value.



Source: Processed by Researchers, 2024
Figure 8. Corrected Reduction Value (CDV)

In Figure 8, the total subtractor value 23 is drawn horizontally in red until it cuts the q1 line then horizontally drawn in red until the corrected subtractor value 21, the total subtractor value 30 is drawn vertically in green until it cuts the q2 line then horizontally drawn until the corrected subtractor value 22, the total subtractor value 36 is drawn vertically in yellow until it cuts q3 then horizontally drawn until the corrected subtractor value 20. So the maximum corrected subtractor value of segment 1 is the value 22 with q equal to 2.

3.5. Calculating Pavement Performance Index (Pavement Condition Index)

Calculating the pavement performance index (PCI) of segment 1 where it is known that the maximum CDV is 18, the pavement performance index (PCI) is calculated with the formula equation = 82%. Calculating the pavement performance index (PCI) of segment 2 where it is known that the maximum CDV is 22, the pavement performance index (PCI) is calculated by the equation formula = 78%. For the overall results of the PCI pavement performance index value can be seen in table 7.

Table 7. Pavement Performance Index (PCI)

Segment	TDV	q	CDV Max	PCI (%)	Road Condition	Handling
1	26	3	18	82	good	periodic
2	30	2	22	78	good	periodic
3	15	1	15	85	good	periodic
4	14	1	14	86	good	routine
5	36	3	27	73	good	periodic
6	55	2	38	62	moderate	upgrades
7	54	2	39	61	moderate	upgrades
8	33	1	32	68	moderate	upgrades
9	28	1	28	72	good	periodic
10	52	3	38	62	moderate	upgrades
11	50	2	35	65	moderate	upgrades
12	38	1	38	62	moderate	upgrades
13	26	3	20	80	good	periodic
14	40	1	40	60	moderate	upgrades
15	38	5	38	62	moderate	upgrades
16	60	3	38	62	moderate	upgrades
17	44	3	40	60	moderate	upgrades
18	60	3	33	67	moderate	upgrades
19	45	3	34	66	moderate	upgrades
20	51	3	30	70	good	periodic
21	62	3	37	63	moderate	upgrades
22	36	1	36	64	moderate	upgrades
23	12	1	12	88	very good	routine
24	37	2	28	72	good	periodic
25	24	1	24	76	good	periodic
26	22	1	22	78	good	periodic
27	7	2	10	90	very good	routine
28	23	2	17	83	good	periodic
29	24	2	17	83	good	periodic
30	16	1	16	84	good	periodic
Average				72,13333	good	periodic

Source: Processed by Researcher, 2024
routine
upgrades

3.6. Calculating the Cost of Handling Pavement Condition Index

The handling of maintenance upgrades based on the East Java Provincial Bina Marga source is:

a. Deployment of CTB on top of the road body exeting with a thickness of 35 cm.
b. Deployment of ATB with a thickness of 6 cm.
c. Deployment of AC-WC hot asphalt with a thickness of 4 cm.
d. Routine handling using AC-WC hot asphalt by patching / taking damaged asphalt to a depth of 5cm as wide as the damaged area is patched with new hot asphalt. The description of maintenance handling is described as follows:

a) Improvement handling is applied to segment 6 (STA 21+000-21+200), segment 7 (STA 21+200-21+400), segment 8 (STA 21+400-21+600), segment 10 (STA 21+800-22+000), segment 11 (STA 22+000-22+200), segment 12 (STA 22+200-22+400), segment 14 (STA 22+600-22+800), segment 15 (STA 22+800-23+000), segment 16 (STA 23+000-23+200), segment 17 (STA 23+200-23+400), segment 18 (STA 23+400-23+600), segment 19 (STA 23+600-23+800), segment 21 (STA 24+000-24+200) and segment 22 (STA 24+200-24+400), handling length of 2600 m, road width of 7 m, handling area of 18200 m^2.

CTB deployment volume = area x thickness
= 18200 x 0,35
= 6370 m3.

ATB deployment volume = area x thickness
= 18200x 0,06 x 2,246
= 2452,63 ton.

AC-WC deployment volume = area x thickness
= 18200 x 0,04 x 2,246
=1635,08 ton.

b) Periodic handling is applied to segment 1 (STA 20+00-20+200), segment 2 (STA 20+200-20+400), segment 3 (STA 20+400-20+600), segment 5 (STA20+800-21+000), segment 13 (STA 22+400-22+600), segment 20 (STA 23+800-24+000), segment 24 (STA 24+600-24+800), segment 25 (STA 24+800-25+000), segment 26 (STA 25+00-25+200), segment 28 (STA25+400-25+600), segment 29 (STA 25+600-25+800) and segment 30 (STA 25+800-26+000), handling length of 2400 m, road width of 7 m, and handling area of 16800 m^2. AC-WC deployment volume = area x thickness x specific gravity. Asphalt = 16800x 0.06x 2.246 = 2263.97 tons.

c) Routine handling in segment 4 (STA 20+600-20+800), segment 23 (STA 24+600-24+800) and segment 27 (STA 25+200-25+400). the handling area is 179.7 m^2 and the volume is the thickness of the patch x area = 0.05 x 179.7 x 2.246 = 20.18 tons.

The cost of upgrading, periodic and routine handling can be seen in Table 8.

Table 8. Total Handling Cost

No	Type of Goods	Unit	Volume	Unit Price (RP)	Cost (RP)
1	2	3	4	5	6=4x5
	Improvement handling				
1	AC-WC t= 4 cm	Ton	1.635,08	1.835.773,00	3.001.635.716,84
2	ATB t= 6 cm	Ton	2.452,63	1.649.042,00	4.044.489.880,46
3	lapis perekat	Liter	10.333,71	22.953,00	237.189.544,64
4	Lapis peresap	Liter	15.500,62	23.585,00	365.582.160,44
5	CTB t= 35 cm	M3	6.370,00	540.216,00	3.441.175.920,00
	Penanganan berkala				
6	AC-WC t= 6 cm	Ton	2.263,97	1.835.773,00	4.156.134.998,81
7	lapis perekat	liter	14.308,29	22.953,00	328.418.189,55
	Penanganan rutin				
8	AC-WC t= 5 cm	Ton	20,18	1.835.773,00	37.045.899,14
9	Lapis perekat	Liter	127,53	22.953,00	2.927.196,09
total cost					15.614.599.505,96

Source: Processed by Researcher, 2024

In table 8 handling with the improvement maintenance method costs Rp. 11,090,073,222.4. For handling periodic maintenance of Rp. 4,484,553,188.36 and for handling routine maintenance of Rp. 39,973,095.23. the total cost of handling is Rp. 15,614,599,505.96,.

4. CONCLUSION

Based on the analysis that has been carried out, it can be concluded that the priority order value of the road surface based on the Pavement Condition Index (PCI) method or the pavement performance index of 72.1% occurs in the Lamongan City – Mojokerto Border road section STA 20+000 - 26+000. Handling with the Pavement Condition Index (PCI) method of the pavement performance index of 72.1% is included in the periodic handling category. The cost of handling road maintenance with the Pavement Condition Index (PCI) method, which includes maintenance of upgrades, periodic maintenance, and routine maintenance, amounted to Rp. 15,240,874,881.40. Based on the results of the research analysis, for better results, suggestions that can be proposed are the need for further research on comparisons using the Geographic Information System (GIS) method and the need for further research on rigid pavement.

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