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Analysis of Damage to Caringin Cikukulu Road, Sukabumi District Using the Pavement Condition Index (PCI) Method

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ABSTRACT

Sukabumi Regency has a very important role in moving the economic and social wheels of society, so it needs to be supported by good flexible pavement conditions. Conditions based on 2020 Bina Marga data show that several roads are seriously damaged in several sub-districts of Sukabumi Regency. Poor implementation, inappropriate planning, excessive traffic loads and standing water on the road surface are the causes of road damage, so to find out this requires a road damage analysis. This researcher used the Pavement Condition Index (PCI) method. The results of this research show that the level of damage to all road surfaces studied according to the PCI method was taken from the average value of each STA, namely, the Caringin Cikukulu road section 62.25. So that the damage that has occurred to the road section does not become worse, it is necessary to immediately take repair action on the damaged units, so that it does not cause further damage. The choice of location for the author's research on the Caringin Cikukulu road was chosen because according to 2020 Bina Marga data the road was badly damaged.

Keywords: road; pavement; Caringin Cikukulu; Pavement Condition Index (PCI); method.

INTRODUCTION

Roads are a means of transportation that connects one place to another. In general, roads are built as infrastructure to facilitate mobility and accessibility of socio-economic activities in society. Referring to the national transportation system, roads have an important role in the community, economy, culture, education, defense and security, etc. Roads as land transportation infrastructure must provide the maximum possible service so that they can be used to support all land activities.

This has been stipulated in Road Law no. 38 of 2004 concerning roads, which stipulates that roads are transportation infrastructure that plays an important role in the economic, social, cultural, environmental, political and defense and security sectors. The situation of disharmony of signs, signals and lighting on the function of the road indicates that the road infrastructure is not a self-explanatory road, which means that the safety information to the user cannot be explained correctly and precisely, so that when crossing bends with substandard geometry the user is not careful (Agus et al, 2009).

The way to assess road conditions visually is the PCI method, in assessing road conditions both from surveys and analysis methods. PCI is a system for assessing road pavement conditions based on the type, level and extent of road damage that occurs, with an index of 0-100 and can be used as a reference in maintenance efforts, namely the assessment of pavement condition is called PCR (Pavement Condition Rating). The higher the PCR value, the better the pavement. The selection of the deduction value is subjective, because it depends on judgment (Jenis Paresa, 2019). In this method, it has economic value and efficiency, so the researchers used road condition assessment using the Pavement Condition Index (PCI) method.

Based on the background above, the author formulates the problem as follows:

1. Type, level and extent of damage to the Caringin Cikukulu road?
2. How to handle damage to Kadudampit roads according to the type and level of damage?

Traffic engineering using the Pavement Condition Index (PCI) is one of the important efforts in

road infrastructure management. PCI is used as an index to assess road surface conditions, ranging from 0 to 100, where a value of 100 indicates excellent road conditions and a value of 0 indicates total damage. In practice, PCI values are used by traffic engineers to make decisions about road maintenance and repair strategies, which are directly related to traffic flow efficiency. Traffic engineering using PCI begins with a visual survey or the use of advanced technology, such as sensors or cameras, to collect road condition data (Syaiful S et.al; Syaiful S, Rusfana H, 2022).

This data is then processed into a PCI value through certain methods, such as the ASTM D6433 method which is a distress-based road assessment standard. After obtaining the PCI value, traffic engineering is applied to minimize disruption to road users during repairs. The importance of PCI in traffic engineering is to provide clear guidance for road managers in planning timely maintenance actions. For example, roads with low PCI values require immediate attention to prevent further damage that can affect road capacity and cause congestion. On the other hand, roads with high PCI values may only require routine maintenance, such as patching cracks or minor repairs Syaiful S, Pratama Y, 2019). Thus, road management becomes more efficient and cost-effective because maintenance can be carried out preventively before damage becomes more severe. In its application, traffic engineers must consider several other factors, such as vehicle volume, type of vehicle passing through, and the time and duration of maintenance. Effective traffic engineering can balance the need to maintain the road with efforts to minimize disruption to traffic flow. In certain situations, traffic engineering can involve traffic diversions, lane restrictions, or the use of traffic control technology to reduce the impact on road users. Overall, traffic engineering with PCI is an integral part of modern road maintenance. This method allows governments and road managers to maintain the quality of transportation infrastructure optimally, ensure traffic flows smoothly, and minimize negative impacts on community activities (Syaiful S et.al, 2022; Syaiful S et.al, 2023).

RESEARCH METHODS

In this study, researchers used the Pavement Condition Index (PCI) method which aims to provide a description and discussion of damage analysis on the Caringin Cikukulu road, Sukabumi district. Research Method Pavement Condition Index (PCI) or Pavement Condition Index developed by the U.S. Army Corp of Engineers is a road pavement condition assessment system, PCI is based on the results of visual condition surveys. In the PCI method, 3 main factors are used, namely:

- Damage type
- Severity of damage
- The amount or density of damage

Of the 3 factors in the Pavement Condition Index (PCI) Method, there are several assessments such as determining the values for road damage, namely:

Table 1. Form of PCI Values and Road Conditions

PCI Value	Condition
86-100	Excellent
71-85	Very good
56-70	Good
41-55	Fair
26-40	Poor
11-25	Very poor
0-10	Fail

PCI is a numerical index whose value ranges between 0-100.
Source: Shahin, 1994

Deduct Value

Deduct value is a deduction value for each type of road damage obtained from the density relationship curve and the level of density (serverity level) of the damage (Shahin, 1994). The

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deduct value can be found by entering the density percentage for each type of damage then drawing a vertical line until it intersects at the level of damage (low, medium, high), then at the intersection a horizontal line is drawn and the Deduct Value is obtained.

Density

Density is the percentage of the total area or length of one type of damage to the total area or length of the road section being measured, which can be in m² or in square meters or long meters (Shahin, 1994).

Kerapatan (density) (%) : $\frac{Ad}{As}$ x 100

Atau

Kerapatan (density) (%) : $\frac{Ld}{As}$ x 100

dengan :

Ad: Total area of one type of pavement for each level of damage severity (m²)

Ld: Total length of type of damage for each level of damage severity (m²)

As: Total area of the sample unit (m²).

Total Deduct Value (TDV)

The total deductible value or TDV is the total sum of the deductible values used as a type of weighting factor which has indicated the degree of influence of the combination of each type of damage, and the severity of the damage in each research unit (Shahin, 1994).

Corrected Deduct Value

The corrected reduction value or CDV is obtained from the relationship curve between the total reduction value (TDV) and the reduction value (DV) by selecting the appropriate curve. If the TDV value is known, we can find the corrected deduct value (CDV), by entering the DV value into Figure 1.

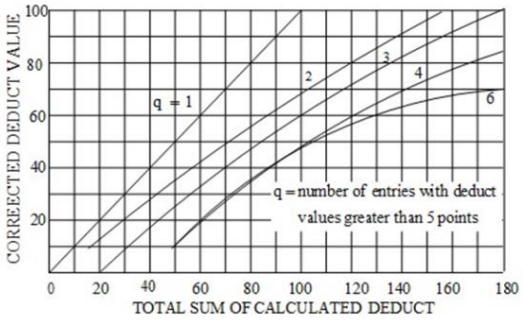

Figure 1. Corrected Deduct Value (CDV) graph

Determination of corrected deduction value or CDV. To find CDV, the method is to draw a vertical line at the TDV value until it intersects the q line, while q is the number of inputs with a deduct value greater than 5, then from the intersection draw a horizontal line to obtain CDV.

PCI value

Shahin (1994), If the CDV value is known, then the PCI value for each sample unit can be calculated using the equation:

PCIs = 100 – CDV

with:

PCIs : Pavement Condition Index for each sample unit or research unit,

CDV : Corrected Deduct Value for each sample unit.

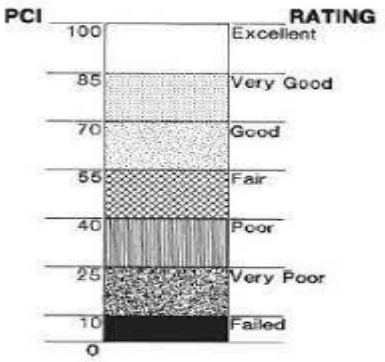

Figure 2. Pavement condition index (PCI) diagram

Road condition rating	Form of handling
70 - 100	Maintenance
40 - 69	Periodic maintenance
0 - 39	Improvement

Figure 3. Handling Condition Value

Method

This research was conducted on the Jl. Caringin Cikukulu, Caringin District, Sukabumi Regency, Answerarat Province, postal code 43154 with the research object on the Caringin Cikukulu road, Sukabumi Regency. The Caringin Cikukulu route is one of the accesses that connects Caringin and Cikukulu.

The location of this research is in the Sukabumi Regency area, namely Jalan Caringin Cikukulu, Caringin District, Sukabumi Regency, West Java. This type of road is a local road, this road is under the authority of Sukabumi district. Along the 900m section of the Caringin Cikukulu road which is the research sampling, the section is divided into 9 segments, each segment has a length of 100 m, starting from the initial STA 0+000 - 0+100 to the final STA 0+800 - 0+900. These road sections were sampled in this research to determine the condition of road damage using the Pavement Condition Index (PCI) method.

Data Analysis

This data analysis was carried out using the pavement condition index (PCI) method which aims to provide a description and discussion of road damage analysis. In the PCI method there are three main factors used, namely:

• Type of damage

• Severity of damage

• The amount or density of damage

Apart from these 3 factors, data researchers are also supported by literature studies related to this research.

On the Caringin Cikukulu road, it is 900 m long. The road section is divided into 9 segments. Inspection and recording of the types of damage and level of road damage is carried out every 100 m. The area of damage to the STA can be calculated as the length times the width of the damage.

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Of the 9 (nine) segments on Jalan Caringin Cikukulu. An example of dividing road segments for data collection in the field can be seen in Figure 4.

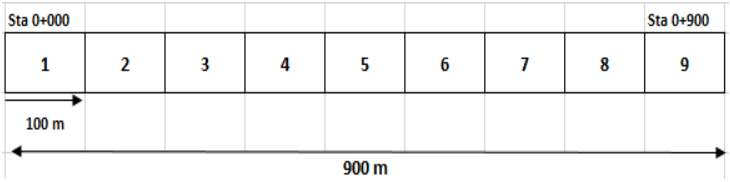

Figure 4. Segment Division

The following is an example of PCI calculation with a sample sta segment. 0+200 - 0+300 with types of patch damage, alligator cracks, and holes.

Damage density (Density)

It is calculated using a formula, namely the ratio between the total area of damage for one type of damage (Ad) the total length of the type of damage (As) for the road times the length for every 100 m.

Patches

For damage (patches), the total damage area is m² with a research unit area of 100 m² with the severity level (level of damage) being M (Medium).

(Density) = $\frac{Ad}{As}$ x 100% =

= $\frac{3.00}{440}$ x 100% = 0,7

Crocodile Crack

For damage (crocodile cracks), the total damage area is m² with a research unit area of 100 m² with the severity level (level of damage) being L (Low).

(Density) = $\frac{Ad}{As}$ x 100% =

= $\frac{1.35}{440}$ x 100% = 0.3%

Hole

For damage (holes), the total damage area is m² with a research unit area of 100 m² with the severity level (level of damage) being L (Low).

(Density) = $\frac{Ad}{As}$ x 100% =

= $\frac{1.53}{440}$ x 100% = 0.3%

Deduct Value

deduct value is a reduction value for each type of damage obtained from the relationship curve of density and severity level of damage. After the density value is obtained, draw a vertical line to cut the severity level value, then draw a horizontal line to get the deduct value.

Patches

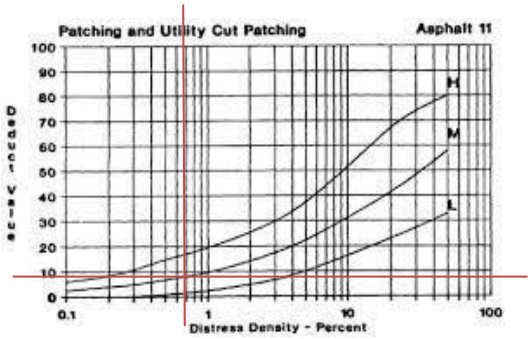

Figure 5. Patch Deduct Value Graph

From the Deduct Value Graph with the type of Patch damage in the graph above with the Density, Low Severity Level and Medium Severity Level values, the Patch Deduct Value value 1 = 8 is obtained.

• **Crocodile Crack**

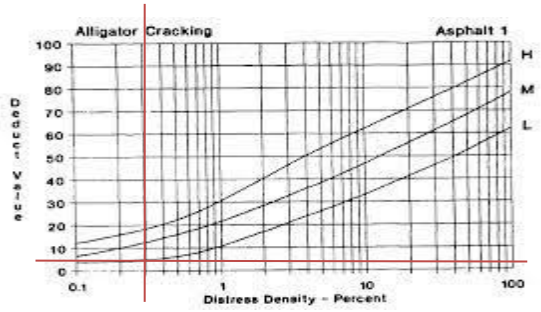

Figure 6. Crocodile Crack Deduct Value Graph

From the Deduct Value Graph with the type of Crocodile Crack damage in the graph above with the Density, Low Severity Level values, the Deduct Value value is obtained = 3

- **Hole**

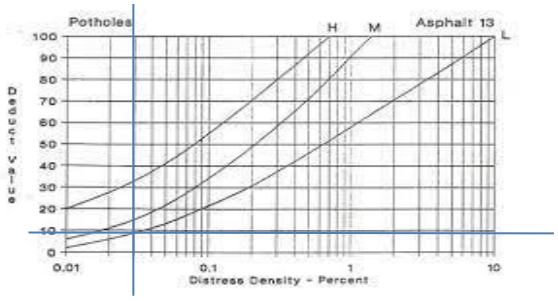

Figure 7. Hole Deduct Value Graph

From the Deduct Value Graph with the type of Hole damage in the graph above with the Density, Low Severity Level values, the Deduct Value value is obtained = 9

Finding the q Value

The q value is taken from the type of damage that is in one sample unit on the road section being studied. The q value at STA 0+200 to 0+300 is 2 (q = 3), because there are 3 types of damage.

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Total deduct value (TDV)

Total deduction value or TDV is the total sum of the deduction values in the sample units.

q = 3 TDV = 29

Corrected Deduct Value (CDV)

From the Total Deduct Value (TDV) results to obtain a CDV graph by entering the TDV value into the CDV graph by drawing a vertical line on the TDV value until it intersects the q line, then drawing a horizontal line.

PCI = 100 – CDV
= 100 – 12
= 88

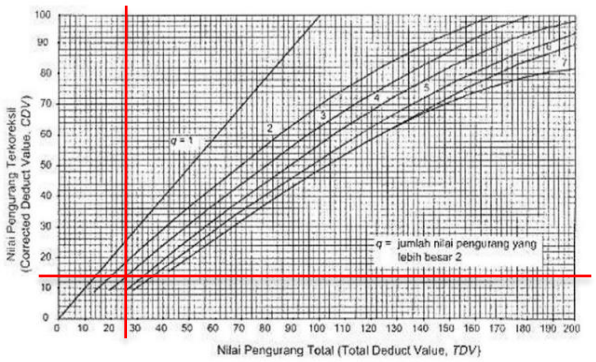

Figure 8. Corrected Deduct Value (CDV) graph

So, the pavement condition value (Pavement Condition Index) is 88 and the PCI rating is Excellent with the form of maintenance treatment.

RESULTS AND DISCUSSION

After conducting a survey in the field and analyzing the condition of road damage on the Caringin Cikukulu road section based on the Pavement Condition Index (PCI) method, the results obtained were the types of road damage in each segment, the PCI value of each segment, and from this PCI value the form of damage management could be determined. roads in each segment based on each segment's road condition value or PCI value. The form of handling road damage in each segment can be seen in Table 2.

Table 2. Analysis of Road Damage in Each Segment (Sta 0+000 to Sta 0+900)

Segment	Stationing	Breakdown Point	Type of Damage	Level of Damage	Area of Damage (m^2)
1	(0+000 - 0+100)	0+075	Collapse	Low	3.00
		0+125	Patch	Medium	3.00
2	(0+100 - 0+200)	0+130	Patch	Medium	2.04
		0+147	Patch	Medium	0.84
		0+175	Crocodile Crack	Low	1.35
		0+180	Crocodile Crack	Low	0.11
		0+190	Hole	Low	1.53
3	(0+200 - 0+300)	0+215	Hole	Medium	7.00
		0+230	Hole	Low	0.96

4	(0+300 - 0+400)	0+280	Hole	Low	1.09
		0+295	Hole	Low	3.12
		0+325	Hole	Low	2.00
		0+350	Crocodile Crack	Medium	6.00
		0+365	Crocodile Crack	Low	1.43
		0+390	Crocodile Crack	Medium	1.95
5	(0+400 - 0+500)	0+430	Crocodile Crack	Medium	2.50
		0+450	Crocodile Crack	Low	1.00
		0+475	Hole	Low	0.10
6	(0+500 - 0+600)	0+525	Hole	Low	0.18
		0+550	Hole	Low	0.20
		0+575	Crocodile Crack	Low	0.69
7	(0+600 - 0+700)	0+650	-	Low	1.44
			Hole	Low	
8	(0+700 - 0+800)	0+725	Hole	Low	0.30
		0+760	Patch	Low	0.12
		0+780	Patch	Low	2.10
		0+790	Hole	Medium	2.40
9	(0+800 - 0+900)	0+825	Patch	Low	0.80
		0+870	Patch	Low	3.00
		0+890	Collapse	Low	1.04

Based on the results of data analysis and discussions that have been carried out, there are several things that can be concluded as follows:

There are 29 types of damage to the main road along the Caringin Cikukulu road, namely:

Crocodile Crack 7 points

Subtract 1 point

7point patch

14 Point Hole

With the results of the analysis carried out, the PCI value for each segment on the Caringin Cikukulu road section can be obtained

Table 3. Determining PCI Values and Road Conditions in Each Segment (Sta 0+000 to Sta 0+900)

Segment	Stationing			Corrected Deduct Value (CDV)	PCI Value (100-CDV)	Road Conditions
1	0+000	-	0+100	5	95	Perfect
2	0+100	-	0+200	12	88	Perfect
3	0+200	-	0+300	97	3	Fail
4	0+300	-	0+400	68	32	Bad
5	0+400	-	0+500	19	81	Very Good
6	0+500	-	0+600	51	49	Fair

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7	0+600	-	0+700	7	93	Perfect
8	0+700	-	0+800	27	73	Very Good
9	0+800	-	0+900	91	9	Fail

The form of handling road damage on each segment of Jalan Caringin Cikukulu based on the results of the Pavement Condition Index (PCI) method analysis is as follows:

Table 4. Road handling based on PCI value for each segment (Sta 0+000 to Sta 0+900)

Segment	Stationing			PCI Value (100-CDV)	Form of Handling
1	0+000	-	0+100	95	Maintenance
2	0+100	-	0+200	88	Maintenance
3	0+200	-	0+300	3	Enhancement
4	0+300	-	0+400	32	Enhancement
5	0+400	-	0+500	81	Maintenance
6	0+500	-	0+600	49	Periodic maintenance
7	0+600	-	0+700	93	Maintenance
8	0+700	-	0+800	73	Maintenance
9	0+800	-	0+900	9	Enhancement

There is a need for immediate maintenance of road damage to reduce accident rates and provide comfort and safety for road users. To prevent road damage from occurring, routine road maintenance is required once a year. If damage occurs, such as on the Jalan Caringin Cikukulu section, repairs should be carried out, so that it does not cause more severe damage.

CONCLUSION

Damage on the Caringin Cikukulu road requires immediate maintenance of road damage to reduce accident rates and provide comfort and safety for road users. To prevent road damage from occurring, routine road maintenance is required once a year. If damage occurs, such as on the Jalan Caringin Cikukulu section, repairs should be carried out, so that it does not cause more severe damage.

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