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Road Damage Analysis Using PCI Method

(Case Study Of Babakan – Pabuaran Road Section Kab. Cirebon)

Martinus Agus Sugiyanto[1], Rossy Indah Lestari[2*]
[1,2]Jurusan Teknik Sipil, Fakultas Teknik, Universitas Swadaya Gunung Jati Cirebon
[2]rossyindah@gmail.com

Abstract

Problematic road infrastructure or pavement due to heavy and repeated traffic volume will cause a decrease in road quality. One of the road damage problems occurred on the Babakan - Pabuaran road section, Cirebon Regency. In this case, the condition survey is carried out visually and then analyzed using the Pavement Condition Index (PCI) method. From the results of data on the condition of the Babakan - Pabuaran road of Cirebon Regency along 3 km and 5 m wide with bending pavement, it can be seen that the more dominant type of damage is the 83.37 m² Basin, 57.27 m² Grain Release, 31.15 m² Hole, 27.08 m² Slippery Aggregate, 21.33 m² Crocodile Skin Crack and 14.92 m² Amblas. The Pavement Condition Index (PCI) value of bending pavement on the Babakan – Pabuaran road section of Cirebon Regency is 41.53 of these figures in the condition of the road section in the Fair category. Based on PCI values, it shows that the percentage of handling road conditions obtained is good, no handling is needed by 14%, rehabilitation by 14%, maintenance by 26% and reconstruction by 46%.

Keywords: Asphalt Pavement Damage, Flexible Pavement, Pavement Condition Index (PCI)

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1. Introduction

Roads are important transportation infrastructure or frameworks that can have an impact on financial, cultural, and social progress in an area [1]. For the welfare of drivers, roads must be facilitated with good pavements [2]. Road foundations that are problematic due to the large number of traffic vehicles and repetition will cause a decrease in road quality [3]. As a marker, this can be seen from the state of the road surface, both the state of the structure and the state of its function which is in a state of disrepair [4].

One of the road damage problems occurred on the Babakan - Pabuaran road section, Cirebon Regency. Road damage on this road is caused by several factors, including the development of vehicle rates that are not as expected, very dense traffic jams (over-loading), poor basic soil conditions, unsatisfactory use of materials and occur due to natural factors. With these conditions, research is expected to determine and compile the type and extent of road pavement damage, as well as determine the value of the Pavement Condition Index (PCI) and strive for its management or handling [5].

Assessment of the state of road asphalt pavement is the main point of view in determining the management or maintenance and repair activities of asphalt pavement [6]. To evaluate the state of road asphalt pavement, it is first important to determine the type of damage, the cause and extent of the damage incurred [7]. Therefore, the author hopes to raise this issue as a topic of discussion with the title "Analysis of Road Damage Using the PCI Method (Case Study of Jl. Babakan – Pabuaran Section, Cirebon Regency)". The purpose of this study was to determine the type of road flexural pavement damage and determine the value of road pavement conditions using the PCI method on the Babakan - Pabuaran Road Section, Cirebon Regency.

The problem statement in this study are: 1) What are the types of damage that occur on the Babakan – Pabuaran road section of Cirebon Regency? 2) How to calculate the value of the state of road surface damage using the PCI method on the Babakan – Pabuaran road section, Cirebon Regency? And 3) How is the handling used by looking at known road damage values?

The problem limitation in this study are: 1) The research was conducted on the Babakan – Pabuaran road, Cirebon Regency, 2) The road section that became a research exploration area was 3 km long, 3) Data analysis using the Pavement Condition Index (PCI) method, and 4) Handling according to the Pavement Condition Index (PCI) method.

Research objectives in this study are: 1) To find out the type of road damage that occurs on the Babakan - Pabuaran road section, Cirebon Regency, 2) To determine the value of road damage using the Pavement Condition Index (PCI) method, and 3) To find out the type of handling used by looking at the value of road damage on the Babakan - Pabuaran road section, Cirebon Regency.

2. Method

This observation was previously started by digging up written survey information from various sources related to road damage or issues to be explored [8]. Then determine the road segment to be investigated and conduct a road condition study to obtain the necessary information data [9]. The flow chart can be seen in Figure 1.

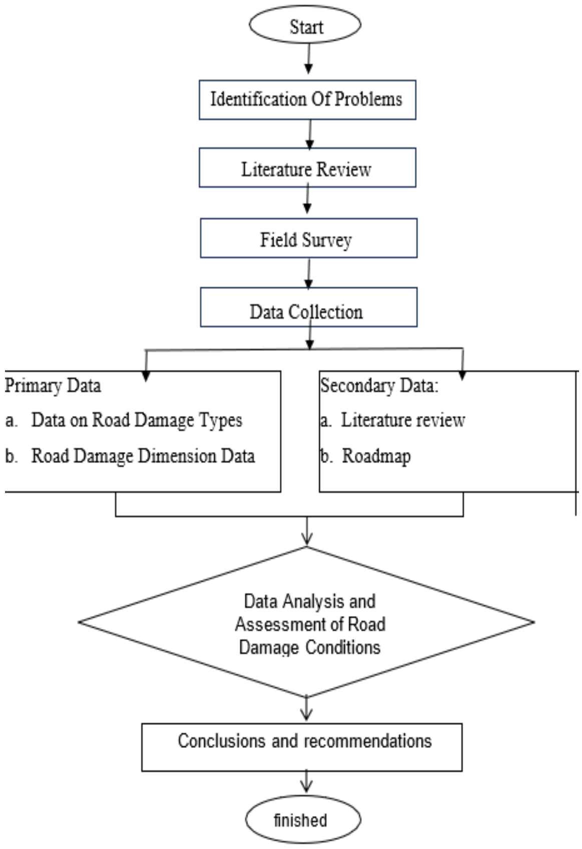

Figure 1. Framework of Thought
Source: Author's Research Results

Objects in the research location of road damage in terms of road section conditions are included in the research population. As for the sample, it is done by assessing the condition of the road and then grouped according to the type of damage and the repair method. The observation area was carried out on the Babakan - Pabuaran road section of Cirebon Regency with a length of 3 km which can be seen in Figure 2.

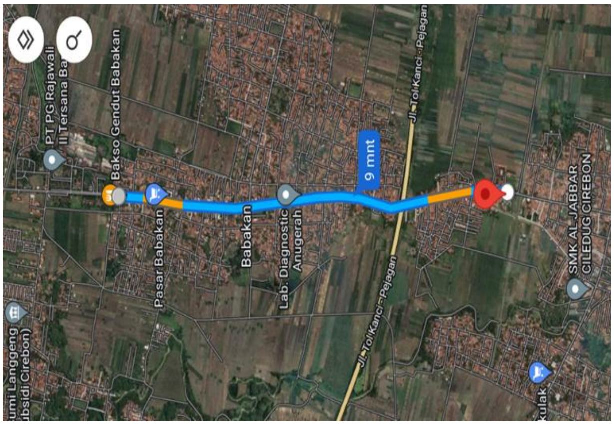

Figure 2 Area Under Study

Source: Google Earth

3. Results and Discussion

Road existing data:
Road Length : 3 km
Road Width : 5 m
Road Functions :Local
Pavement Type : Flexible Pavement
Location : Kec.Babakan–Kec.Pabuaran Cirebon District

Information data on road damage conditions was collected by reviewing observations with visual perception, i.e. classifying and quantifying the damage that occurred in the inspection area by estimating the length and width of the damage, and then obtaining the area of each damage. The classification, extent and magnitude of road surface damage were combined into an overview structure in the form of a survey form based on the findings of the field investigation. Data collection on the 3 km road was divided into 15 segments with a distance of 200 m per segment and can be seen in table 1.

Table 1. Road Data Retrieval Area

1	2	3	4	5
200	200	200	200	200
6	7	8	9	10
200	200	200	200	200
11	12	13	14	15
200	200	200	200	200

3.1 Pavement Condition Index (PCI) Analysis

The calculation uses the sample part of segment 1 as an example. Data recapitulation of survey results can be seen in table 2. While segment 1 calculation results can be seen in table 3.

a. Determining Density

Ad/As x 100%

Luas total unit segmen 1 = 200 m x 5 m = 1000 m^2
1L (Alligator Cracking) = 0.80 / 1000 x 100% = 0.080%
6L (Depression) = 0.44 / 1000 x 100% = 0.044%
6M (Depression) = 0.42 / 1000 x 100% = 0.042%
7L (Edge Cracking) = 0.09 / 1000 x 100% = 0.009%
12L (Polished Aggregate) = 0.48 / 1000 x 100% = 0.048%
13L (Potholes) = 0.85 / 1000 x 100% = 0.085%
13M (Potholes) = 0.91 / 1000 x 100% = 0.091%

Table 2. Recapitulation Data of Survey Results

JENIS KERUSAKAN	1. Alligator Cracking			6. Depression				11. Patching & Util. Cut Patching					16. Shoving		
	2. Bleeding			7. Edge Cracking				12. Polished Aggregate					17. Slippage Cracking		
	3. Block Cracking			8. Jt. Reflection Cracking				13. Potholes					18. Swell		
	4. Bumps and Sags			9. Lane/Shoulder Drop Off				14. Railroad Crossing					19. Weathering/Raveling		
	5. Corrugation			10. Long & Trans Cracking				15. Rutting							
DATA PERSEGMEN	1. 0.80 (L)	4. 1.08 (M)	4. 1.75 (H)	4. 6.60 (H)	1. 12.25 (M)	1. 0.70 (L)	4. 3.20 (M)	1. 0.72 (L)	1. 0.72 (M)	1. 0.15 (L)	1. 1.76 (M)	4. 4.20 (M)	1. 0.48 (M)	1. 0.36 (L)	1. 0.35 (L)
	6. 0.44 (L)	4. 7.65 (H)	4. 8.96 (H)	5. 3.52 (M)	11. 1.60 (L)	4. 13.00 (H)	4. 8.10 (H)	4. 6.00 (H)	1. 0.94 (M)	3. 2.40 (M)	3. 3.78 (M)	7. 1.05 (M)	7. 0.09 (L)	13. 0.07 (L)	3. 0.52 (L)
	6. 0.42 (M)	4. 7.50 (H)	6. 4.83 (M)	6. 2.70 (M)	12. 3.75 (L)	13. 0.63 (L)	6. 1.53 (L)	4. 6.44 (H)	1. 2.80 (H)	4. 1.80 (H)	4. 2.80 (H)	10. 0.36 9L)	7. 0.28 (L)	13. 0.15 (L)	7. 0.15 (L)
	7. 0.09 (L)	5. 3.06 (M)	13. 0.61 (L)	12. 2.73 (L)	12. 9.45 (H)	13. 0.90 (L0	7. 0.34 (L)	6. 2.24 (L)	4. 3.15 (H)	7. 0.84 (M)	5. 1.30 (L)	13. 0.72 (L)	13. 0.08 (L)	19. 0.33 (L)	13. 0.30 (L)
	12. 0.48 (L)	6. 1.41 9L)	13. 0.34 (L)	12. 1.12 (M)	13. 0.96 (L)	13. 0.88 (M)	11. 10.80 (M)	7. 2.00 (H)	4. 15.00 (H)	12. 1.98 (M)	7. 0.20 (L)	13. 0.68 (L)	19. 0.32 (L)	19. 0.72 (L)	19. 0.56 (L)
	13. 0.02 (L)	6. 1.80 (L)	13. 0.46 (L)	13. 0.13 (L)	13. 4.25 (L)	13. 0.40 (M)	12. 1.07 (L)	11. 8.96 (M)	7. 0.80 (H)	13. 0.46 (L)	7. 0.70 (M)	13. 0.12 (L)	19. 0.60 (L)		19. 1.02 (L)
	13. 0.57 (L)	10. 1.80 (H)	13. 0.23 (L)	13. 3.24 (H)	13. 0.61 (L)	13. 1.08 (M)	13. 0.26 (L)	13. 0.70 (L)	11. 8.00 (H)	13. 0.27 (L)	13. 0.72 (L)	13. 0.28 (L)	19. 1.20 (L)		19. 2.85 (M)
	13. 0.02 (L)	13. 0.11 (M)	13. 1.04 (L)		13. 1.05 (L)	19. 1.10 (M)	13. 0.51 (L)	13. 1.20 (L)	12. 6.50 (L)	13. 0.63 (L)	13. 2.47 (M)	13. 0.45 (L)			
	13. 0.07 (L)	13. 0.13 (M)	13. 2.96 (M)		13. 0.18 (L)	19. 2.52 9M)	13. 3.80 (M)	13. 1.20 (M)	13. 1.19 (L)	13. 1.12 (H)	19. 1.44 (L)	13. 0.28 (L)			
	13. 0.13 (L)	19. 4.14 (M)			13. 0.14 (M)		13. 0.88 (M)	19. 0.86 (M)	13. 1.20 (L)	19. 0.60 (L)	19. 0.80 (L)	13. 1.30 (L)			
	13. 0.05 (L)	19. 12.00 (H)			19. 13.92 (H)		13. 0.60 (M)		13. 0.56 (H)	19. 3.84 (M)	19. 1.45 (M)	13. 1.80 (M)			
	13. 0.91 (M)	19. 9.60 (H)					19. 0.75 (L)		19. 3.04 (H)			18. 3.40 (M)			
		15.00 (H)					19. 1.30 (L)		19. 5.06 (H)			19. 3.33 (M)			
							19. 1.86 (M)								
STA	0+000 - 0+200	0+200 - 0+400	0+400 - 0+600	0+600 - 0+800	0+800- 1+000	1+000 - 1+200	1+200 - 1+400	1+400 - 1+600	1+600 - 1+800	1+800 - 2+000	2+000 - 2+200	2+200 - 2+400	2+400 - 2+600	2+600 - 2+800	2+800 - 3+000
LEBAR	5 M	5 M	5 M	5 M	5 M	5 M	5 M	5 M	5 M	5 M	5 M	5 M	5 M	5 M	5 M
PANJANG	3000 M														

Table 3. Segment 1 Calculation Results

SEGMEN	1	STA	0+000 - 0+200	PANJANG JALAN	200	m
SURVEYED BY		LEBAR JALAN	5 m	LUAS JALAN	1000	m

1. Alligator Cracking	6. Depression	11. Patching & Util. Cut Patching	16. Shoving
2. Bleeding	7. Edge Cracking	12. Polished Aggregate	17. Slippage Cracking
3. Block Cracking	8. Jt. Reflection Cracking	13. Potholes	18. Swell
4. Bumps and Sags	9. Lane/Shoulder Drop Off	14. Railroad Crossing	19. Weathering/Raveling
5. Corrugation	10. Long & Trans Cracking	15. Rutting	

DISTRESS SEVERITY	QUANTITY										TOTAL	DENSITY %	DEDUCT VALUE
1L	0.80										0.80	0.080	5
6L	0.44										0.44	0.044	3
6M	0.42										0.42	0.042	8
7L	0.09										0.09	0.009	0
12L	0.48										0.48	0.048	0
13L	0.02	0.57	0.02	0.07	0.13	0.05					0.85	0.085	21
13M	0.91										0.91	0.091	32
												HDVi	32
												Mi	7.24

DEDACT VALUE							TDV	q	CDV	PCI	KONDISI
32	21	8	5	3	0	0	69	5	34	31	POOR
32	21	8	5	3	0	2	71	4	41		
32	21	8	5	3	2	2	73	3	46		
32	21	8	5	2	2	2	72	2	54		
32	21	8	2	2	2	2	69	1	69		

b. Determining Deduct Value

The density value of 0.080% severity level low (L) is obtained by a value of 5. The density value of 0.044% severity level low (L) is obtained by a value of 3. The density value of 0.042% severity level medium (M) obtained a value of 8. The density value of 0.009% severity level low (L) is obtained by a value of 0. The density value of 0.048% severity level low (L) is obtained by a value of 0. The density value of 0.085% severity level low (L) is obtained by a value of 21. The density value of 0.091% severity level medium (M) obtained a value of 32. DV Alligator Cracking, DV Depression 1, DV Depression 2, DV Edge Crack Image, DV Polished Aggregate, DV Hole 1, DV Hole 1, and DV Hole 2 can be seen in Figure 3, Figure 4, Figure 5, Figure 6, Figure 7, Figure 8, and Figure 9, respectively.

HDVi Value = Largest Deduct Value
HDVi value = 32

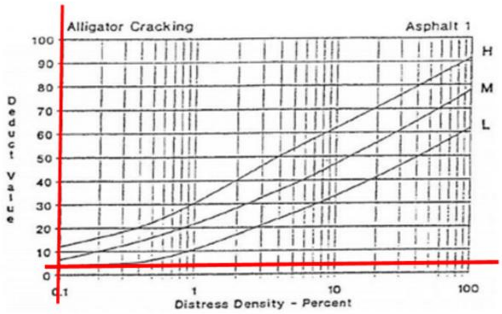

Figure 3. DV Alligator Cracking

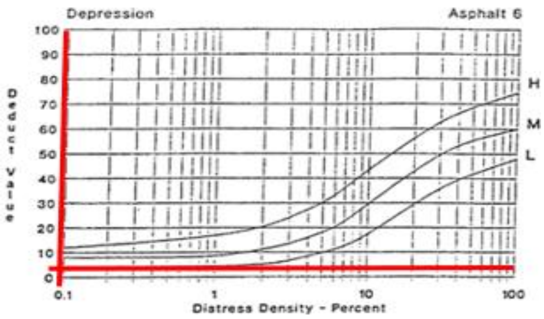

Figure 4. DV Depression 1

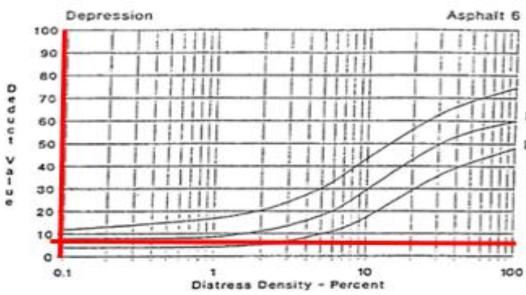

Figure 5. DV Depression 2

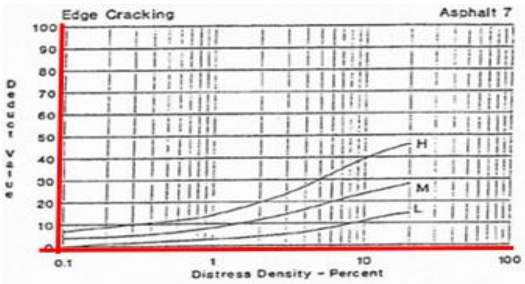

Figure 6. DV Edge Cracking Images

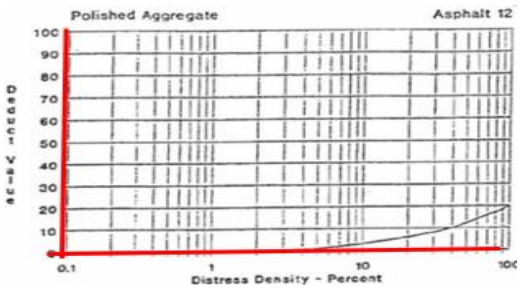

Figure 7. DV Polished Aggregate

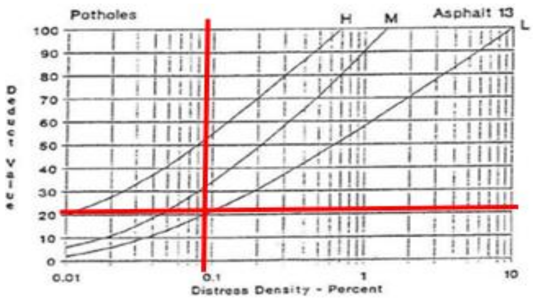

Figure 8. DV Potholes 1

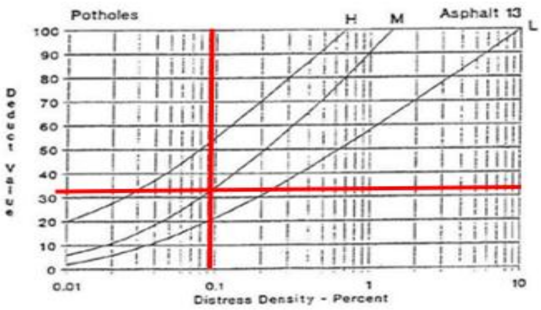

Figure 9. DV Potholes 2

c. Allowable Maximum Deduct Value (m)

m $= 1 + (9 / 98)\ (100 – HDVi)$

$= 1 + (9 / 98)\ (100 – 32) = 7.24$

The total m, including its fractional part, is the sum of the data of each subtraction value.

d. Total Deduct Value (TDV)

By adding up all the reduction values, it can be known the Total Reduction Value (TDV) of the road sections used in the study. In order for the q value to fall, subtract a value that is almost equal to two. This process is then continued until the value of q = 1 is reached. TDV value can be seen in table 4, while the CDV graph can be seen in figure 10.

Table 4. Iteration looking for TDV values

DEDACT VALUE							TDV	q
32	21	8	5	3	0	0	69	5
32	21	8	5	3	0	2	71	4
32	21	8	5	3	2	2	73	3
32	21	8	5	2	2	2	72	2
32	21	8	2	2	2	2	69	1

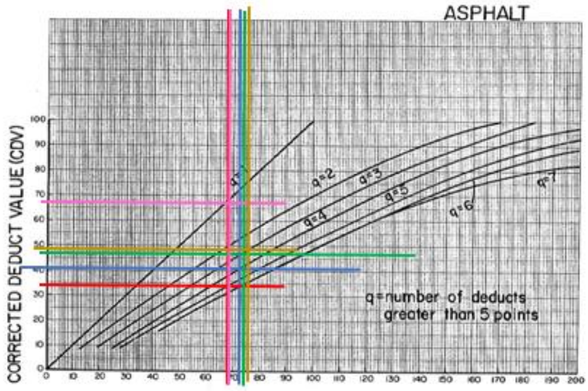

Figure 10. CDV graphics

e. Corrected Deduct Value (CDV)

Using a CDV graph, find CDV based on TDV and q values. It will then obtain the CDV value by slicing the CDV graph using the q and TDV values.

f. Pavement Condition Index (PCI)

The value of 100 is subtracted by the maximum CDV to determine the PCI value.

PCI = 100 – CDV maximum
PCI = 100 – 69
PCI = 31 (Segment 1)

g. Total PCI Value Recapitulation of All Segments

= (31+45+11+31+33+18+32+35+22+35+41+37+87+89+76) / 15= 623 / 15 = 41.5 (Fair) PCI index value can be seen in Figure 11. Reference PCI value can be seen in Table 5. Road Handling can be seen in Table 6. While the calculation CDV can be seen in Table 7.

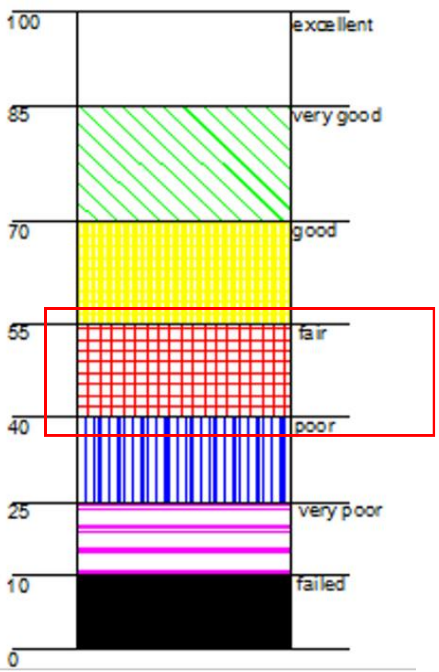

Figure 11. PCI Index Value Graph

Table 5. Road Handling Decision Reference PCI Value

Repair Time	PCI		
	Arterial Roads	Collector Roads	Local Roads
No improvement yet	> 85	> 80	> 80
6 - 10 more years of maintenance	76 - 85	71 - 80	66 - 88
1 - 5 more years of maintenance	56 - 75	51 - 70	46 - 65
Now Rehab	50 - 55	45 - 50	40 - 45
Now Reconstruction	< 50	< 45	< 40

Table 6. Road Handling Based PCI value

Segment	PCI Value	Handling
1	31	Reconstruction
2	45	Rehabilitation
3	11	Reconstruction
4	31	Reconstruction
5	33	Reconstruction
6	18	Reconstruction
7	32	Reconstruction
8	35	Reconstruction
9	22	Reconstruction
10	35	Reconstruction
11	41	Rehabilitation
12	37	Reconstruction
13	87	Maintenance
14	89	-
15	76	Maintenance

Table 7. Calculation of SDI

Panjang Jalan	3000							
STA	0+000 - 0+200	0+200 - 0+400	0+400 - 0+600	0+600 - 0+800	0+800 - 1+000	1+000 - 1+200	1+200 - 1+400	1+400 - 1+600
LEBAR JALAN	5	5	5	5	5	5	5	5
15 segmen / 200m	200	200	200	200	200	200	200	200
Lebar Retak (m)	1.35	3	0	0	2.5	0.7	0.4	1.1
Panjang Retak (m)	1.07	0.6	0	0	4.9	1	0.85	5.2
Luas Retak (m2)	1.44	1.80	0	0	12.25	0.70	0.34	2.72
Luas Segmen (m2)	1000	1000	1000	1000	1000	1000	1000	1000
Luas Retak (%)	0.14	0.18	0.00	0.00	1.23	0.07	0.03	0.27
Jumlah Lubang	7	2	6	2	6	5	5	3
Rata - rata Kedalaman Rutting (cm)	0	0	0	0	0	0	0	0
SDI1 (Luas Retakan)	5	5	0	0	5	5	5	5
SDI2 (Lebar Retakan)	5	5	0	0	5	5	5	5
SDI3 (Jumlah Lubang)	20	20	15	15	20	20	20	20
SDI4 (Bekas Roda)	20	20	15	15	20	20	20	20
	20	20	10	10	20	20	20	20
Kondisi Jalan Menurut SDI	Baik	Baik	Baik	Baik	Baik	Baik	Baik	Baik

Panjang Jalan							
STA	1+600 - 1+800	1+800 - 2+000	2+000 - 2+200	2+200 - 2+400	2+400 - 2+600	2+600 - 2+800	2+800 - 3+000
LEBAR JALAN	5	5	5	5	5	5	5
15 segmen / 200m	200	200	200	200	200	200	200
Lebar Retak (m)	3.35	1.95	3.45	0.55	1.15	0.4	1.05
Panjang Retak (m)	7.9	4.4	7	4.8	2.6	0.9	3
Luas Retak (m2)	5.26	3.39	6.44	1.41	0.85	0.36	1.02
Luas Segmen (m2)	1000	1000	1000	1000	1000	1000	1000
Luas Retak (%)	0.53	0.34	0.64	0.14	0.09	0.04	0.10
Jumlah Lubang	3	4	2	8	1	2	1
Rata - rata Kedalaman Rutting (cm)	0	0	0	0	0	0	0
SDI1 (Luas Retakan)	5	5	5	5	5	5	5
SDI2 (Lebar Retakan)	5	5	5	5	5	5	5
SDI3 (Jumlah Lubang)	20	20	20	20	20	20	20
SDI4 (Bekas Roda)	20	20	20	20	20	20	20
	20	20	20	20	20	20	20
Kondisi Jalan Menurut SDI	Baik	Baik	Baik	Baik	Baik	Baik	Baik

h. Handling of Road Conditions Based on Pavement Condition Index (PCI) Value

To ensure that the treatment plan is considered effective for the condition of the pavement, it must be repaired based on the type of damage. Based on the results of road condition analysis based on PCI values in each segment, road handling can be carried out for each segment on the Babakan-Pabuaran Road, Cirebon Regency. Based on PCI values, the percentage of handling road conditions on the Babakan - Pabuaran road section of Cirebon Regency is declared good without requiring repair by 14%, rehabilitation by 14%, maintenance by 26%, and reconstruction by 46%. The information is depicted in the table above.

i. Reconstruction

For example, segment 1, for example, must be reconstructed. Segment 1 has poor pavement condition, hence frequent road maintenance is required. This maintenance includes the entire pavement structure, drainage, road shoulders, ravines, and curbs are all repaired as part of this maintenance. The upgrade increases the strength of construction by resurfacing or backfilling road shoulders and pavements according to the specified age. Maintenance and cleaning of rumaja and repair of related structures.

j. Rehabilitation

For example, segment 2 must be rehabilitated, Based on the results of PCI calculations, segment 2 has poor road conditions, causing a decrease in stability conditions in some areas with minimal damage, making it possible to follow a plan to restore reduced strength conditions.

Periodic road maintenance includes resurfacing, repairing road shoulders, replacing or repairing auxiliary buildings, and repairing road equipment potholes, handling emergency response, work related to backfilling, excavation, basic soil preparation, structural pavement work, making or repairing drainage, marking, scraping of roads without pavements and closed roads, maintenance and cleaning of houses.

k. Maintenance

For example in segment 13 that was explored, the pavement condition value is 87 (very good), but if there is damage left open at a shallow level then the weakening of the condition will be much faster because unhindered water will enter different layers.

If preventive maintenance or minor recovery support is not carried out during the existence of the road plan, then the damage to the pavement will be even worse. Maintenance outside and around the pavement will reach a stage where significant restoration support (structural repair) is required, for example repairing the entire road, adding a thick layer of thickness (thick overlay) or even remaking, maintenance of the pavement at a fairly thick level, this stage requires a very large cost.

When a pavement is in poor condition with greater rupture damage compared to maintenance for example, preventive assistance cannot currently be utilized but it is too early to get significant recovery stage treatment, pavement with this stage condition receives minor restoration treatments such as extra fine layers. In addition, for asphalt conditions that still look good, maintenance such as preventive support and minor restorations as well as regular maintenance is the best choice.

l. Road Damage Assessment Analysis Using Surface Distress Index (SDI) Method

Road condition assessments can then be performed to ascertain SDI values for each identified segment based on information and the weight of any road damage obtained from field surveys. The value (SDI) of the Babakan – Pabuaran road section of Cirebon Regency is calculated as follows:

m. Comparison of Pavement Condition Index (PCI) and Surface Distress Index (SDI) Results

This correlation is intended in research is an examination of signs of system response to the type of damage associated with actual condition data in the field. The following are processed data from both PCI and SDI methods, and can be seen in Table 8.

Table 8. Results of PCI and SDI Methods

STA	*Pavement Condition Index* (PCI)	Surface Distress Index (SDI)
0+000 – 0+200	Poor	Good
0+200 – 0+400	Poor	Good
0+400 – 0+600	Very Poor	Good
0+600 – 0+800	Poor	Good
0+800 – 1+000	Poor	Good
1+000 – 1+200	Very Poor	Good
1+200 – 1+400	Poor	Good
1+400 – 1+600	Poor	Good
1+600 – 1+800	Very Poor	Good
1+800 – 2+000	Poor	Good
2+000 – 2+200	Poor	Good
2+200 – 2+400	Poor	Good
2+400 – 2+600	Excellent	Good
2+600 – 2+800	Excellent	Good
2+800 – 3+000	Very Good	Good

4. Closing

4.1 Conclusions

The conclusions that can be drawn from research conducted on the Babakan-Pabuaran road section in Cirebon Regency are as follows:

1. From the recapitulation of data on the condition of the Babakan-Pabuaran road along 3 km and 5 m wide in Cirebon Regency, it can be seen that the most dominant type of damage is the 83.37 m² Basin, 57.27 m² Grain Release, 31.15 m² Hole, 27.08 m² Slippery Aggregate, 21.33 m² Crocodile Skin Crack and 14.92 m² Amblas.
2. On the Babakan-Pabuaran road section of Cirebon Regency, the PCI value of flexural pavement is 41.53. This figure shows that the Babakan-Pabuaran road section is in fair condition. To determine the PCI Value using 3 parameters namely damage classification, destruction rate or damage density.
3. The handling of road conditions on the Babakan-Pabuaran road in Cirebon Regency based on PCI values shows that the percentage of handling road conditions obtained is good, there is no need for handling by 14%, rehabilitation by 14%, maintenance by 26% and reconstruction by 46%.

4.2 Suggestion

1. For better results, the parties involved are expected to periodically assess road conditions so that things like the above do not happen.
2. Handling must be done immediately for the safety and comfort of motorists who pass through the road section.

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