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EVALUATION OF ROAD DAMAGE AND MAINTENANCE USING THE PAVEMENT CONDITION INDEX METHOD CASE STUDY ON JALAN SUKAHAJI - MAJA

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ABSTRACT

The road is a facility that is very important for the community to achieve a desired goal, for that we need a road that is safe and comfortable for its use. Road damage often occurs every year, especially on roads that are often traversed by vehicles with a lot of volume (congested) and vehicles that are heavily loaded (overloaded) such as on the Sukahaji – Maja road, which causes the speed of users to slow down (drop) and have an impact on reducing population mobility and the economy of the surrounding community. The purpose of this research is to determine the level of road damage using the Payment Condition Index (PCI) method. The survey method or PCI refers to ASTM D6433 (Standard Practice for Roads and Parking Lots Pavement Condition Surveys). Pavement Condition Index (PCI) is a road pavement condition assessment system based on the type, level, and extent of damage that occurs and can be used as a reference in maintenance efforts. This PCI value has a range of 0 to 100 with the criteria of excellent, very good, good, fair, poor, very poor, and failed. Based on the analysis using the PCI method, for the type of damage that occurs on the Sukahaji-Maja road for the flexible pavement/asphalt type, 6 types of damage occur, namely alligator cracking, striping, grain release, collapse, vanished, and potholes. In Table 4.2 the average PCI value obtained is then entered into the parameters as in the table so that the road can be categorized as damaged, namely Poor (Damaged). So this road needs to be included in a road improvement program on an ongoing basis.

1. Introduction

The road is a facility that is very important for the community to achieve a desired goal, for that we need a road that is safe and comfortable for its users. However, over time, road conditions will decrease in quality, which can be caused by several factors, namely the weather and the age of the road which can hamper the smooth running of these road users. Therefore it is necessary to determine the type of maintenance and proper handling so that damage to the road can be handled and repairs to the condition of the damaged road are carried out immediately (Mu'is, 2022)

Damage to highways, especially in Indonesia, is under the spotlight because several national or regional road segments need to be repaired. excessively repeated which results in shorter road life than planned. Inappropriate planning, weak supervision, and implementation that is not in line with existing plans. In addition, inadequate maintenance costs, delays in budget spending, and improper handling are also contributing factors to road damage (Mu'is, 2022)

A road must be supported by good pavement, namely for the comfort and safety of the road users. Road pavement is divided into two categories, namely flexible pavement and rigid pavement. Flexible pavement is a pavement that uses asphalt as a binder while rigid pavement is a type of road pavement that uses concrete as the main ingredient of the pavement. (Letsoin, 2021)

In the Majalengka area, especially on Jalan Raya Sukahaji - Maja, it is one of the roads that must be evaluated. This road is a regency road that connects the two sub-districts and this road is also the only alternative road if the main road is under repair/diversion. This road is also often traversed by overloaded vehicles or those that exceed the maximum load limit, resulting in damage to the road and increased load on the road surface by vehicle wheels, poor subgrade conditions and inappropriate materials used, environmental factors, and implementation. which did not go according to plan. Various types of damage can occur on flexible pavement, therefore research is needed to determine the condition of the road surface by making visual observations. Literature Review with the Pavement Condition Index (PCI) Method (Rachman & & Sari, 2020)

The Pavement Condition Index (PCI) method is a road pavement condition assessment system based on type and level of damage so that it can be used as a reference in maintenance and repair efforts. The PCI method provides information on pavement conditions only at the time the survey was conducted, but cannot provide a predictive picture in the future. However, by conducting periodic condition surveys, pavement condition information can be useful for predicting future performance, as well as being used as input for more detailed measurements. (Yamali, Handayani, & & Sirait, 2020)

Based on the background above, the purpose of this research is to identify the type of damage and maintenance and find out the PCI value to get priority for the handling and maintenance of the road.

2. Literature Review

2.1 Road Pavement

Pavement is a part of road construction consisting of several layers or layers, located on a foundation or subgrade that is designated for traffic lanes and must be strong enough to meet two main requirements, namely the first traffic requirements such as the road surface not wavy, not deflected, not perforated, quite stiff, and not shiny. In addition, the road must be able to withstand the force of friction or wear and tear on the wheels of the vehicle. While the next condition is the overall strength/structural pavement must be strong enough to carry and spread a load of traffic passing over it. In addition, it must be watertight, the surface easily drains water and has sufficient thickness (Gemo, 2019)

Pavement is divided into two categories, namely flexible pavement and rigid pavement. Flexible pavement (flexible pavement) Flexible pavement is a layer pavement method, where asphalt is a binding material from its constituent materials such as coral, sand, and filler, and has the property of evenly distributing the load received from the vehicle to the lower foundation, which refers to the 2017 Design Manual Method (Sukarno, 2022)

As for rigid pavement, Rigid Pavement is a type of road pavement that uses concrete as the main pavement material. Rigid pavement is a type of road pavement that is often used apart from flexible pavement (asphalt). This pavement is generally used on roads that have quite dense traffic conditions and have a large load distribution, such as inter-provincial crossroads, flyovers, toll roads, as well as at signalized intersections. These roads generally use concrete as a pavement material, but to increase comfort, the pavement surface is usually covered with asphalt (Darmawan & Lizar, 2020)

2.2 Damage to Flexible Pavement ((flexible pavement)

Flexible pavement or flexible pavement is a type of pavement where the surface layer consists of an asphalt mixture, as well as granular material as the bottom layer or as the foundation layer (Maharani & Wasono, 2018). Flexible Pavement consists of a solid structure that has many layers. The top layer of flexible pavement is covered with bitumen as a binder layer. Over time, a decrease in strength may occur in the asphalt, caused by environmental factors, such as heat and rain. Flexible pavement structures will eventually suffer damage due to repeated vehicle loads. The causes of road damage are caused by vehicle loads, rainwater, construction structures, weather, subgrade conditions, and poor compaction work. (Hermawan & Tajudin, 2021)

Pavement damage on roads is generally divided into two parts, namely structural damage and functional damage. As for the types of damage to these parts, the first is structural damage consisting of cracks, deformation, surface defects, wear and tear, grease, and settlement of former utility plantings. While the

types of functional damage to the road consist of several types, namely, the uneven surface area of the track (*roughness)* and deflections that cause inconvenience to the road users. (Mutoharoh, Wahidin, Feriska, & Taufiq, 2022)

damage especially on flexible pavements (flexible pavements) can be caused by several factors, namely the first is deformation, changes to the pavement surface after construction on the road surface. Deformation can affect the quality of traffic comfort and can indicate damage to the pavement structure from damage to bumps and drops, collapses, grooves, wavy, expands, and slumps. Then there are cracks, which are pavement damage that occurs in various forms and for various causes. For example, cracks are caused by fatigue from repeated stresses due to vehicle loads. Cracks can also occur when the pavement is subject to maximum tensile stress. Some kind of crack damage on the asphalt surface. The cracks consist of block, diagonal, reflective, crocodile skin, crescent, longitudinal, and transverse damage (Rahayu, 2022)

Furthermore, there is surface texture damage consisting of stripping damage, grease, slippery aggregate, flaking, and loose grains. Damage for potholes consists of rail crossings and patches. Damage at the edge of the pavement consists of damage to the side and dropped shoulders. The following is an explanation of the types of damage above according to each type of road damage. Damage at the edge of the pavement is damage along the shoulder of the road that borders the asphalt pavement. This damage occurs along the edge of the pavement and sometimes occurs only in one section of the road (Fitri, 2022)

2.3 PCI (Pavement Condition Index) Method

The PCI method is a method that provides information on pavement conditions only at the time the survey is conducted, but cannot provide a predictive picture in the future. However, by conducting periodic condition surveys, pavement condition information can be useful for predicting future performance, as well as being used as input for more detailed measurements. (Rinaldi, Lestari, & Pramita, 2022)

The PCI method was developed to provide an index of pavement structural integrity and surface operational conditions. The damage information obtained as part of the PCI condition survey provides information on the causes of the damage, and whether the damage is load or climate-related. The PCI method is a method that is a road damage assessment system whose function is to determine the road pavement index, three important points in the PCI method, namely the type of damage, severity, and total density. The PCI method is a method that is a road damage assessment system where the function is to determine the road pavement index (Mulyanto, 2019)

Pavement Condition Index (PCI) is an assessment of the condition of road pavement based on the type, extent, and extent of damage to the road as well as a reference in maintenance efforts. Assessment of road conditions can be seen from the level of road damage (*Severity Level)*. The level of damage used in PCI calculations is *low severity level* (L), *medium severity level* (M), and *high severity level* (H *)* . , deduct value. Deduct value is a deduction value for each type of road damage obtained from the density and severity level relationship curve. (AS, 2021)

Furthermore, the total deduct value (TDV) The total deduct value or TDV is the total amount of the deduct value used as a type of aggravating factor which has indicated the degree of influence of the combination of each type of damage, and the severity of the existing damage. Then determine the q value. Determining the q value can be found from how much damage is done to each sample unit, in 1 sample unit, for example, 100 m sample units, and how many damages there are. If there are 2 damages, the q value obtained is 2 pieces, and the q value is the value that follows from the multiple defects in its sample units. The q value is needed to draw the line for the Corrected Deduct Value (CDV) graph. Corrected Deduct Value Corrected deductible value or CDV is obtained from the curve of the relationship between the total reduction value (TDV) and the reduction value (DV) by selecting the appropriate curve. If the CDV value is known then the overall pavement PCI value on a particular road section can be calculated or determined (AS, 2021)

3. Method

This research is located in Padahanten Village, Sukahaji District, Majalengka Regency, 1.4 KM long out of a total of 4.1 KM Sukahaji-Maja road to precise from the Nurul Ikhlas Mosque to the Jami At-Taqwa Abu Salam Mosque. While the time of this research was conducted in March – July 2023.

Figure 1 Research location

A systematic scientific research process must begin with the identification of the right problems. (Rifai, Hadiwardoyo, Correia, & Pereira, 2016)This research uses literature studies and data collection. Data collection techniques are observation and documentation. Observation techniques are data collection techniques by conducting a preliminary survey and also taking data directly to the location, including visual surveys of the types of road damage that occurred on Jalan Sukahaji - Maja, while the documentation technique is data collection techniques. by taking pictures and photos of road damage. A literature study is a series of activities related to methods of collecting library data, reading and taking notes, and managing research materials.

The data that has been obtained from the survey is that this road has a pavement width of 2x3.5 m with a flexible pavement of Laston asphalt and the type of road is still 2 lanes in 2 directions without a median (2/2 UD). Data is one of the main strengths in compiling research and modeling scientifically, data processing in this study used the Pavement Condition Index (PCI) method. The analysis carried out in this study included the types of damage to flexible pavements based on the Pavement Condition Index (PCI) method, total deduct value (TDV), corrected Deduct Value, CDV), PCI Value, Value of road conditions and types of maintenance and handling of road damage

After the survey is completed, a set of data will be obtained that will be used in the calculations. The next step is to process the data

1. Starting from the survey, what was done was:
   a. Dividing each segment into several sample units, in this study the sample units were divided every 100 meters.
   b. Determine the level of damage (severity level).
   c. Measure the dimensions of the damage in each sample unit.
   d. Record measurement results to survey data.
2. Analysis of road conditions using the Pavement Condition Index (PCI) method, starting from:
   a. Calculate the density (degree of damage).
   b. Determine the deduct value of each type of damage
   c. Calculate the total deduct value (TDV).
   d. Determine the corrected deduct value (CDV).
3. Calculates the PCI (Pavement Condition Index) value.
   a. Calculating density which is the percentage of the area of damage to the area of the research unit uses formulas 1 and 2.
   b. Calculating the value of the reduction (deduct value).
   c. Calculate the total deduct value (TDV) for each research unit.
   d. Calculating the corrected deduct value (CDV) for each research unit.
   e. Calculating the pavement condition index (PCI) value for each research unit, using formulas 3 and

f. Calculate the average PCI value of all research units on a road studied to get the PCI value of the road.
g. Determine road pavement conditions using PCI values.

4. Determine the type of road damage based on the PCI value
   - 0 to 10 = Failed (Failed)
   - 11 to 25 = Very Poor (Very Poor)
   - 26 to 40 = Bad (Poor)
   - 41 to 55 = Moderate (Fair)
   - 56 to 70 = Good (Good)
   - 71 to 85 = Very Good
   - 86 to 100 = Perfect (Exellent).

4. Results and Discussion

Based on the data collection that has been carried out on the Sukahaji-Maja road section, there is some damage to the road. The data that has been obtained from the survey results are as follows:

Table 4.1 Data Collection

No	STA (M)	Damage type	Damage Class	P(M)	L(M)	A(M^2)
1	STA 0+000 to STA 0+100	Crocodile cracked skin	M	0.62	1.34	0.830
2	STA 0+100 to STA 0+200	Hole Crocodile cracked skin Grain Release	L H H	0.36 0.70 0.64	0.40 1.23 0.82	0.144 0.824 0.524
3	STA 0+200 to STA 0+300	Grain Release	M	1.50	2.57	3,855
4	STA 0+300 to STA 0+400	Grain Release Crocodile cracked skin	H H	0.74 0.34	0.58 1.67	0.429 0.576
5	STA 0+400 to STA 0+500	Grain Release Spade	H H	0.87 0.60	1.77 0.58	1,534 0.348
6	STA 0+500 to STA 0+600	Crocodile cracked skin Spade Hole Grain Release	H L H H	0.55 2.05 0.40 1.47	0.72 0.52 0.74 1.51	0.396 1,066 0.296 2,219
7	STA 0+600 to STA 0+700	Spade disappear Grain Release	H L L	0.83 1.27 0.50	0.66 0.59 0.45	0.547 0.749 0.225
8	STA 0+700 to STA 0+800	Grain Release striping Hole Hole	L L H H	0.35 1.30 0.77 0.66	0.33 0.56 0.91 0.35	0.115 0,,728 0.700 0.231
9	STA 0+800 to STA 0+900	Grain Release Grain Release Grain Release	H H H	0.45 1.09 0.40	1.20 0.23 1.42	0.54 0.250 0.568
10	STA 0+900 to STA 1+000	Hole Grain Release	L M	0.13 0.11	0.80 0.25	0.104 0.027
11	STA 1+000 to STA 1+100	striping Grain Release	H H	3.30 0.71	3.01 1.20	9,933 0.852
12	STA 1+100 to STA 1+200	Hole	M	0.20	0.25	0.05

		Grain Release	L	0.41	0.15	0.061
		striping	L	0.60	0.49	0.294
13	STA 1+200 to STA 1+300	Hole	L	0.54	0.46	0.248
		Hole	L	0.57	0.44	0.248
		Hole	H	0.60	0.49	0.294
		Hole	M	0.15	0.15	0.025
		Grain Release	L	0.15	0.90	0.135
		Grain Release	M	0.30	0.55	0.165
14	STA 1+300 to STA 1+400	Grain Release	H	0.83	1.03	0.854
		hole	M	0.21	0.15	0.31

Data from the survey results can then be calculated for the density value of each road damage:

a. Crocodile cracked skin
   For alligator crack damage (STA 0+000 to STA 0+100) the total area of damage is 0.830 m^2 with an area greater than 100 m^2 then it is included in the Severity Level category is M (Medium).
   Density $= \frac{Ad}{As}$ x100%
   Density $= \frac{0,830}{350}$ x100%
   Density $= 0.237$ %
a. Hole
   For hole damage (STA 0+100 S/d STA 0+200) the total damage area is 0.144
   Density $= \frac{Ad}{As}$x 100%
   Density $= \frac{0,144}{350}$x 100%
   Density $= 0.041$ %
b. Crocodile cracked skin
   For alligator crack damage (STA 0+100 to STA 0+200) the total damage area is 0.824 m^2 with an area larger than 100 m^2 then included in the Severity Level category is H (Hour).
   Density $= \frac{Ad}{As}$ x100%
   Density $= \frac{0,824}{350}$ x100%
   Density $= 0.235$ %
c. Grain Release
   For alligator crack damage (STA 0+100 to STA 0+200) the total damage area is 0.524 m^2 with an area larger than 100 m^2 then included in the Severity Level category is H (Hour).
   Density $= \frac{Ad}{As}$ x100%
   Density $= \frac{0,524}{350}$ x100%
   Density $= 0.150$ %

The following calculations can be seen in the table below. The table contains a summary of the calculations including DV, TDV, and CDV Then determine the PCI value so that the STA can be directly included in whether the road is damaged or not.

Table 4.2 Calculation Results of the PCI Method

No	STA	density	DV	TDV	CDV	PCI	Ket
1	STA 0+000 to STA 0+100	0.237	10	10	58	42	*Poor*
2	STA 0+100 to STA 0+200	0.041 0.235	5 17	36	68	32	*Poor*

		0.150	14				
3	STA 0+200 to STA 0+300	1.101	22	22	52	48	*Poor*
4	STA 0+300 to STA 0+400	0.122 0.164	13 12	25	61	39	*Poor*
5	STA 0+400 to STA 0+500	0.043 0.100	11 12	23	63	37	*Poor*
6	STA 0+500 to STA 0+600	0.113 0.304 0.084 0.634	15 20 18 25	78	70	30	*Poor*
7	STA 0+600 to STA 0+700	0.156 0.749 0.214	11 7 6	24	60	40	*Poor*
8	STA 0+700 to STA 0+800	0.115 0.032 0.2 0.066	21 12 40 13	86	73	27	*Poor*
9	STA 0+800 to STA 0+900	0.154 0.071 0.162	19 48 15	82	68	32	*Poor*
10	STA 0+900 to STA 1+000	0.029 0.007	10 20	30	65	35	*Poor*
11	STA 1+000 to STA 1+100	2,838 0.243	40 17	57	63	37	*Poor*
12	STA 1+100 to STA 1+200	0.014 0.017 0.084	8 5 7	20	68	32	*Poor*
13	STA 1+200 to STA 1+300	0.070 0.070 0.084 0.007 0.038 0.047	18 18 7 3 8 11	62	85	15	*Very Poor*
14	STA 1+300 to STA 1+400	0.244 0.088	17 40	57	62	38	*Poor*

From the calculation table above, it can be seen that the total PCI value is = 484 so the average for the 1.4 KM Sukahaji-Maja road section can be obtained as follows:

$$\text{PCIs} = \frac{PCLS}{N}$$

$$\text{PCIs} = \frac{484}{14}$$

$$\text{PCIs} = 34.5$$

Then based on the PCI value that has been obtained on the Sukahaji-Maja road section along 1.4 KM STA 0+000 to 1+400 it is categorized as Poor (*Poor)* which means that the pavement or road must be repaired immediately so as not to hinder and threaten safety the road users.

5. Conclusion

Based on the analysis using the PCI method, for the type of damage that occurs on the Sukahaji-Maja road for the flexible pavement/asphalt type, 6 types of damage occur, namely alligator cracking, striping, grain release, collapse, vanished, and potholes. In Table 4.2 the average PCI value obtained is then

entered into the parameters as in the table so that the road can be categorized as damaged, namely *Poor* (Damaged) so that this road needs to be included in the road improvement program on an ongoing basis. So that the damage that has occurred to the Sukahaji-Maja road section does not get worse, it is necessary to immediately take corrective action on the damaged units so that they do not cause further damage.

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