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EVALUATION ROAD DAMAGE USING THE PAVEMENT CONDITION INDEX (PCI) METHOD

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ABSTRACT
Roads are one of the infrastructures that play a very important role in development in a region for economic growth and public welfare, especially in Indonesia. when the construction of road pavements according to their function was introduced. In order to maintain the quality of road services, one of these efforts is to evaluate the condition of damage to the road pavement, namely by reviewing measurements of the condition of the road surface. This condition also applies to the Tambakboyo Highway section, Lamongan Regency, East Java Province, where, like other roads, every year there is traffic growth due to the increasing population, causing the road pavement construction to be damaged. In this study, a study was conducted to calculate road damage using the pavement condition index (PCI) method and to calculate the estimated cost of repairs that need to be done. The results of the analysis of the estimated cost of road repairs based on the budget plan) show that the total cost of the work, including 11% Value Added Tax, reached IDR 5,440,000.00. The largest cost component is found in STA 0+600 – 0+800, which requires quite large repair costs, in accordance with the pavement conditions that require patching.
Keywords: *road damage; pavement condition index (PCI); cost estimation*

1. Introduction

Roads are one of the infrastructures that play a very important role in development in a region for economic growth and public welfare, especially in Indonesia. In general, the development of pavement construction in Indonesia has begun to grow rapidly since 1970, when the construction of road pavements according to their function was introduced. Road pavement is a mixture of aggregates and binding materials used to serve traffic loads [1] To ensure that roads continue to be able to meet mobility needs with certain service standards, various strategic steps are needed to maintain the quality of road services, one of which is through periodic repair of road surface conditions. One of the stages in repairing road surface conditions is to assess the existing condition of the road. Choosing the right form of road management also plays a role in ensuring that the allocation of development budgets can be used effectively and efficiently [2]

Lamongan Regency has a fairly important role in driving the wheels of the economy and social community, so it needs to be supported by good road conditions. Especially the Tambakbouo Highway section in Lamongan Regency which is an urban road that is densely populated with vehicles. The area on this road section is a road area leading to schools, supermarkets and kiosks where there are several vehicles passing through. Good road pavement conditions are very important to ensure comfort, safety, and traffic efficiency. For this reason, an accurate and systematic evaluation method is needed in assessing the level of road damage. The Pavement Condition Index (PCI) is one of the methods commonly used to assess pavement conditions based on the type, severity, and extent of road surface damage, with the aim of providing a quantitative basis for decision making related to maintenance and rehabilitation.

Therefore, this study attempts to evaluate the road conditions on the Tambakboyo Highway construction project in Lamongan Regency in order to determine the condition of the completed road. The value of this road condition will later be used as a reference to determine the type of handling that must be carried out.

2. Material and Method

Pavement Condition Index (PCI) is a numerical measure used to describe the level of roadworthiness and surface condition of a road pavement based on its functionality and level of damage. This assessment is carried out by considering various forms of damage that are visually visible in the field, such as the type of damage, severity, and area affected. PCI is expressed on a scale from 0 to 100, where a value of 0 indicates a pavement condition that is very damaged and unsuitable for use, while a value of 100 reflects a very good or perfect pavement condition. The PCI method was developed with the aim of providing indicators of the structural integrity of the road and the performance of the surface in serving traffic. The information obtained from this survey not only displays the actual condition, but also makes it possible to identify the main cause of damage, whether caused by heavy vehicle loads, environmental factors, or a combination of both. In accordance with the main discussion of the research which aims to evaluate road damage using the pavement condition index (PCI) method and estimate road repair costs.

2.1. Location Analysis and Planning

The road section reviewed is a flexible pavement with 2 lanes and each road is above the surface of the Tambakboyo Highway section with a length of 1.4 km.

Figure 1. Research Location Sketch

2.2. Planning Stages

In this data collection stage, the data collected is divided into 2 (two) types, the data is as follows:

1. Primary Data

   Primary data is a type of data collected directly from its primary source through the process of observation and measurement in the field, which is carried out in actuality at the location of the research object. The primary data required in this study are as follows:

   a. Identification of types of road damage (pictures of types of road damage) on the Tambakboyo Highway section.
   b. Road section measurement data (length, width).
   c. Documentation photos of road conditions.

2. Secondary Data

   Secondary data is information obtained from previously available sources, whether from government agencies, related institutions, scientific literature, reference books, research reports, academic journals, or other documents that are relevant to the topic of study and support the implementation of research analysis. 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 maps).

Road pavement conditions using the Pavement Condition Index (PCI) method can be described as follows:

1. Calculating Density (D).
2. Determining Deduct Value (DV).
3. Determining Allowable Maximum Deduct Value (M).
4. Determining Total Deduct Value (TDV).
5. Determining Corrected Deduct Value (CDV).

6. Calculating Pavement Condition Value using PCI method.

3. Result and Discussion

3.1. Road Damage Assessment Analysis Using the Pavement Condition Index (PCI) Method

The results of the visual survey using the Pavement Condition Index (PCI) method on the 1.4 kilometer Tambakboyo Highway section showed variations in damage conditions on the road body. This study used 7 (seven) sample units as a representation of road pavement conditions, where each sample unit has a segment length of 200 meters. Based on the results of field identification, the damage conditions recorded in each sample unit showed different levels of severity. Identification data and determination of pavement conditions for each sample unit on the road section can be presented as follows.

Table 1. Field Survey Data

ASPHALT SURFACED ROADS & PARKING LOTS CONDITION SURVEI DATA SHEET UNIT										SKETCH	: 200 m : 5 m		
1. Retak Kulit Buaya (m^2) 2. Kegemukan (m^2) 3. Retak Kotak-Kotak (m^2) 4. Cekungan (m) 5. Keriting (m^2) 6. Amblas (m^2)		7. Retak Pinggir (m) 8. Retak Sambung (m) 9. Retak Jalan Turun Vertikal (m) 10. Retak Memanjang/Melintang (m) 11. Tambalan (m) 12. Pengausan Agregat (m)								13. Lubang (counts) 14. Alur (m^2) 15. Sungkur (m^2) 16. Patah Slip (m^2) 17.Mengembang (m^2) 18.Pelepasan Butir (m^2)			
STA	DISTRESS SURVEI	QUANTITY								TOTAL	DENSITY (%)	DEDUCT VALUE	TOTAL
0+000 - 0+200	10 L	2,5	0,5	1	2	8	2,5	4	6	26,50	2,65	7	12
	18 M	0,14								0,14	0,01	5	
0+200 - 0+400	10 L	2	1	1,5	2,3	2,5	1	3		13,30	1,33	5	11
	18 M	2,3								2,30	0,23	6	
0+400 - 0+600	10 M	1,5	1,2	1,4	3	2				9,10	0,91	10	25
	13 L	0,09	0,07	0,09	0,05					0,30	0,03	9	
	18 M	1,5	2							3,50	0,35	6	
0+600 - 0+800	10 M	1	5	3	6	14	7			36,00	3,60	19	93
	11 L	2								2,00	0,20	0	
	13 L	0,003	0,002	0,001	0,002	1,43	1,65	0,125	0,004	3,22	0,32	39	
	18 H	1,22	9,01	8,65	8,7	10,7	1,26	12	16	67,54	6,75	35	
0+800 - 1+000	10 L	5	1,2	2,2	4	10,5	5			27,90	2,79	9	17
	18 H	12,5								12,50	1,25	8	
1+000 - 1+200	10 L	13								13,00	1,30	5	24
	18 H	1,2	3,3	2,8	2	8				17,30	1,73	19	
1+200 - 1+400	10 L	2,5	3							5,50	0,55	4	27
	11 L	4								4,00	0,40	1	
	18 H	27								27,00	2,70	22	

3.2. Road Pavement Condition Assessment Using PCI Method

Based on the problems and research methods presented, the data obtained from the survey results will be discussed to determine the type and level of damage depending on the condition of the Tambakboyo Highway section from STA 0+000 - 1+400. The level of road damage is determined from the depth or width of the damage determined based on visual observation. Factors that affect the density of damage are the quality of each damage and the area of the section being reviewed. The deduct value is calculated immediately after the level of damage and density are obtained. After the results are known, the next step is to calculate the Total Deduct Value (TDV) and

Corrected Deduct Value (CDV). Then determine the value (PCI) as the final step in analyzing the condition of the road pavement.

The following is a sample unit of PCI calculation on STA 0+600 - 0+800

1. Calculating Density

   The density value is obtained from the following formula:

   $Density\ (\%) = \frac{\sum \text{extent of one type of damage}}{\text{Pavement area}}$ x 100%

   1. Longitudinal/Transverse Cracking

      $Density = \frac{AD}{AS}$ x 100%

      $Density = \frac{36}{1000}$ x 100%

      Density = 3,6 %

   2. Patching

      $Density = \frac{AD}{AS}$ x 100%

      $Density = \frac{2}{1000}$ x 100%

      Density = 0,2 %

   3. Potholes

      $Density = \frac{AD}{AS}$ x 100%

      $Density = \frac{3,22}{1000}$ x 100%

      Density = 0,32 %

   4. Weathering/Raveling

      $Density = \frac{AD}{AS}$ x 100%

      $Density = \frac{67,54}{1000}$ x 100%

      Density = 6,75 %

2. Determining Deduct Value

   To get the deduct value, enter the density value into the deduct value graph by drawing vertical lines on the deduct value until it intersects lines L, M, and H, then draw a horizontal line.

   a. Longitudinal/Transverse Cracking

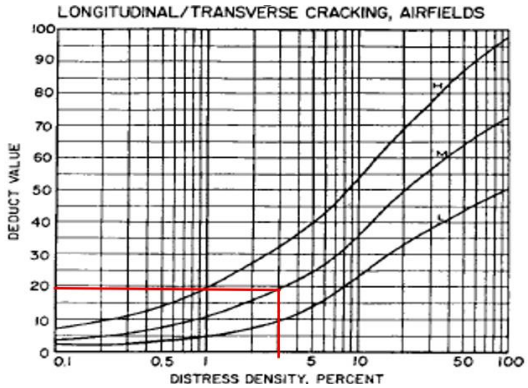

Figure 2. DV Graph of Longitudinal/Transverse Crack Damage

Figure 2 shows the graph of deduct value of longitudinal/transverse crack damage is 19.

b. Patching

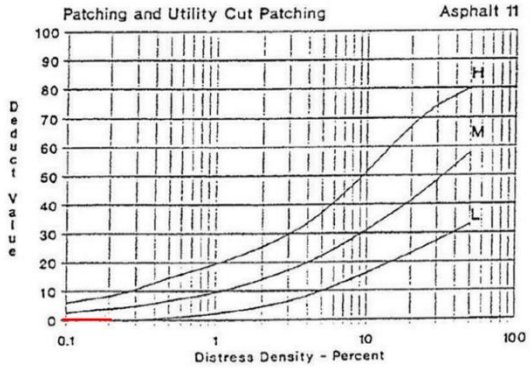

Figure 3. Patch Damage DV Graph

Figure 3 shows a graph of the deduct value of patch damage is 0.

c. Potholes

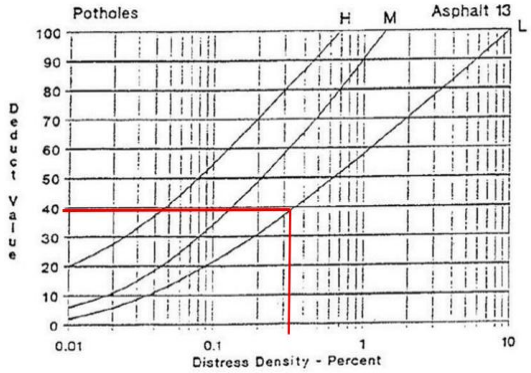

Figure 4. Hole Damage DV Graph

Figure 4 shows a graph of the deduct value of hole damage is 39.

d. Weathering/Raveling

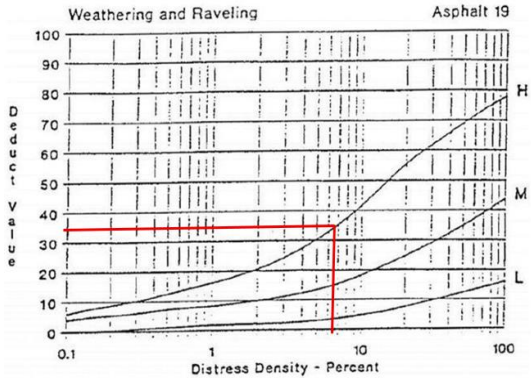

Figure 5. Grain Release Damage DV Graph

Figure 5 shows the graph of the deduct value of grain release damage is 35.

3. Calculating Allowable Maximum Deduct Value (m)

Before the calculation process of the Pavement Condition Index (PCI) value is carried out, the initial step that must be taken is to verify the threshold value or permit value first as a basic reference for evaluating the pavement condition. In this study, if there is only one deduct value with a value > 2, then the TDV value is used as the CDV value. If not, it is continued to a special stage. The initial step taken is to arrange or sort the deduct value from the highest to the lowest value. Then, the m value is determined by the following formula:

$m = 1 + (9/98)*(100 - HDV) = \leq 10$

where HDV is high deduct value. If the sum of the deduct value data exceeds the value of m, then the value of the deduct value data that exceeds the allowable value m is multiplied by the remaining value of m. If the sum of the deduct value data does not exceed the value of m. then the value of m is not used, and the next analysis can be continued.

$m = 1+ (9/98)*(100-39) = 6{,}60 \leq 10$

because the value of m is less than 10, then the value of m does not apply to this STA.

4. Determining Corrected Deduct Value (CDV)

The CDV value is obtained by entering the total deduct value (TDV) into the CDV graph, namely by drawing a vertical line from the TDV value to intersect the q line, then continuing by drawing a horizontal line. An example of calculating the CDV value for the STA 0+600 to 0+800 segment can be seen in Table 4.3 and Figure 4.9 as a reference for obtaining the CDV value. To determine the q value, it is determined by the sum of the individual deduct value of each damage whose value is greater than 5 on the road segment being studied.

Table 2. Corrected Deduct Value (CDV) Calculation

STA	Deduct Value				Total	q	CDV
0+600 - 0+800	19	0	39	35	93	3	59

From the results of Table 2, the Corrected Deduct Value is then entered into the Total Deduct Value (TDV) graph as shown in the graph below.

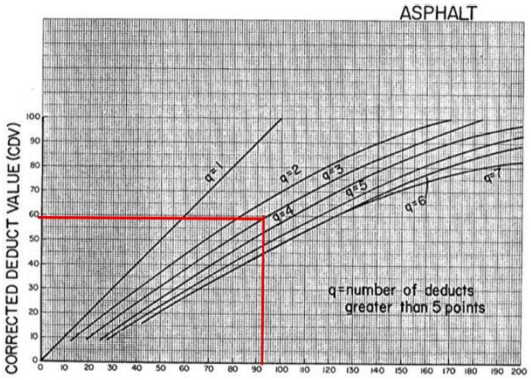

Figure 6. Corrected Deduct Value (CDV) STA 0+600-0+800 graph

In the image above, you can see the maximum corrected reduction value (CDV) at STA 0+600-0+800 is 59.

5. Determining PCI STA Value 0+600 – 0+800

PCI = 100 – CDVmax

= 100 – 59

= 41 poor

PCI index with a value between 41-55 identifies that the road pavement value at STA 0+600 – 0+800 is categorized as poor. Complete calculations can be presented below as follows.

Table 3. PCI STA Result 0+000 - 1+400

No.	STA	CDV	PCI	Level of Damage
1	0+000 - 0+200	9	91	*Good*
2	0+200 - 0+400	11	89	*Good*
3	0+400 - 0+600	13	87	*Good*
4	0+600 - 0+800	59	41	*Goor*
5	0+800 - 1+000	14	86	*Good*
6	1+000 - 1+200	23	77	Satisfactory
7	1+200 - 1+400	31	69	*Fair*
Average		22,86	77,14	Satisfactory

From Table 3 shows the average PCI value is categorized in satisfactory condition because it shows a value of 77.14, where 77.14 is in the range of 70-85 for satisfactory

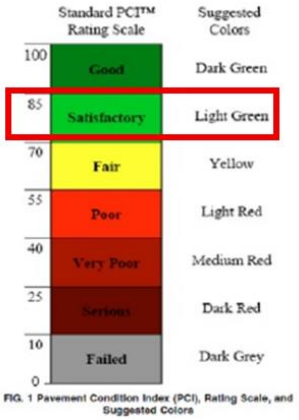

FIG. 1 Pavement Condition Index (PCI), Rating Scale, and Suggested Colors

conditions. The following is a graph of PCI values on the Tambakboyo Highway section STA 0+000 - 1+400.

Figure 7. Pavement Quality Qualification STA 0+000-1+400

Figure 7 is a graph showing the PCI STA 0+000-1+400 values that have been generated in calculations using the PCI method. The average value on the Tambakboyo Highway is 77.14 in satisfactory condition.

3.3. Road Repair Cost Estimates

The following is an estimate of the cost of work used to repair road damage on the Tambakboyo Highway, Lamongan Regency.

From Table 4, the results of the recapitulation of the Budget Plan for the Tambakboyo Highway Rehabilitation activity located in Tikung District, Lamongan Regency, East Java, obtained a total cost of work of Rp 5,440,000.00 after rounding. The cost includes public works of Rp 390,000.00 and repair work in three road segments, namely STA 0+600 - 0+800 of Rp 3,948,613.31, STA 1+000 - 1+200 of Rp 365,257.75, and STA 1+200 - 1+400 of Rp 241,177.31. Other segments do not require cost allocation because they are still in good condition and only require routine maintenance that is not significant in terms of budget.

Tabel 4 Road Repair Cost Estimate

REKAPITULASI
RENCANA ANGGARAN BIAYA (RAB)

Kegiatan : **Rehabilitasi Jalan Raya Tambakboyo**
Lokasi : **Kec. Tikung**
Kab. Lamongan - Jawa timur

No. Divisi	Uraian	Jumlah Harga Pekerjaan (Rupiah)
1	UMUM	390.000,00
2	STA A 0+000 - 0+200	0,00
3	STA A 0+200 - 0+400	0,00
4	STA A 0+400 - 0+600	0,00
5	STA A 0+600 - 0+800	3.948.613,31
6	STA A 0+800 - 1+000	0,00
7	STA A 1+000 - 1+200	365.257,75
8	STA A 1+200 - 1+400	241.177,31
(A)	Jumlah Harga Pekerjaan (*termasuk Biaya Umum dan Keuntungan*)	4.945.048,37
(B)	Pajak Pertambahan Nilai (PPN) = 10% x (A)	494.504,84
(C)	JUMLAH TOTAL HARGA PEKERJAAN = (A) + (B)	**5.439.553,21**
	DIBULATKAN	**5.440.000,00**

4. Conclusion

The results of the analysis of road repair cost estimates based on the budget plan show that the total cost of the work, including 11% Value Added Tax (VAT), reaches IDR 5,440,000.00 (Five Million Four Hundred and Forty Thousand Rupiah). The largest cost component is in STA 0+600 – 0+800, which requires quite large repair costs, in accordance with the condition of the pavement that requires patching and periodic maintenance. The results of this cost estimate reinforce the urgency of implementing maintenance on road sections that are experiencing a decline in condition. Efficient and targeted budget preparation is essential to support the effectiveness and sustainability of road functions.

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