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# Analysis of Damage For Flexible and Rigid Pavement Using Pavement Condition Index (PCI) and Bina Marga Methods (Case Study: Narogong Cileungsi – Bantar Gebang Highway)

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## Abstract

Roads are a necessity that must be considered as infrastructure that plays an important role in various fields of life. Jalan Raya Narogong which is located in the province of West Java is an inter-city provincial road that connects Bogor Regency with Bekasi City which is the center of community service offices, industrial areas and so on. The purpose of this study is to determine the type and amount of damage on the Narogong Cileungsi – Bantar Gebang STA 0+000 – 12+000 highway along 12 km with a road width of 10 m. By visual observation, the data measured in the form of the dimensions of the area of damage and the volume of vehicles crossing the road were analyzed using the Pavement Condition Index (PCI) and Highways Method. Furthermore, the Damage Calculation was divided into Segments and Perslab with the area of the segment being 100 m² and the Perslab area being 50 m². . Based on the analysis carried out to find the level of damage to the Narogong Highway using the PCI method, the pavement condition value was 93 with excelent criteria. Meanwhile, the bina marga method on the Narogong highway requires a routine maintenance program. From the two methods, the strategy for handling damage is to carry out routine maintenance and in some segments it is necessary to improve.

**Keywords**
Road Damage, Rigid Pavement, PCI, Bina Marga, Flexible Pavement,

## 1. Introduction

Transportation is the movement of passengers and goods from one place to another. In transportation, there are two most important elements, namely movement and physical displacement of goods or passengers with or without transportation equipment to other places. (Hadihardaja & Joetata, 1997). In carrying out their daily lives, humans are always closely related to transportation, especially roads.

Road pavement is a construction layer placed on the ground (subgrade) which has undergone compaction and has a function to support traffic loads which then spread it to the road so that the soil does not receive the permitted land capacity. The purpose of making a road pavement layer is to achieve a certain style so that it is able to support traffic loads and can distribute and distribute vehicle wheel loads that are received to the ground (Sukirman, 1994).

Jalan Raya Narogong which is in the province of West Java is an inter-city provincial road that connects Bogor Regency with Bekasi City which is the center of community service offices, industrial areas, markets and road access to several schools, so activities and activities are quite busy. Based on data from the Central Statistics Agency for Bogor Regency and Bekasi City (Central Statistics Agency,) (Badan Pusat Statistik Kabupaten Bogor, 2021) the population based on SP2021 results is 5,132,355 million people for Bogor Regency and 3,805.2 million people for Bekasi Regency, most of the sub-districts in Bogor and Bekasi. has a fairly high population density.

Based on field observations in some parts of the road there is quite severe damage such as holes, cracks, and subsidence. Seeing this condition, the Narogong highway was chosen as the point to be reviewed. This can result in discomfort and even harm to road users. Therefore, it is necessary to identify and damage the level of

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damage to the Narogong Cileungsi highway using the Bina Marga method and the Pavement Condition Index (PCI).

## 2. Research Methodology

Basically every pavement structure will undergo a progressive destruction process since the road is first opened to traffic. To overcome this, a method is needed to determine road conditions so that they can be prepared for the road maintenance program to be carried out (Sulaksono, 2021)

### 2.1. Pavement Condition Index Method

Pavement Condition Index (PCI) is an estimate of road conditions with a rating system to state the actual pavement condition with reliable and objective data. The PCI method was developed in America by the U.S. Army Corp. of Engineers for airport pavements, highways and parking areas, because with this method accurate data and condition estimates are obtained according to conditions in the field. The PCI level is written in levels 0-100, see figure 1. According to (M.Y. Shahin, 1994) The condition of the pavement is divided into several level.

Table 1. PCI Vale and Pavement Condition (M.Y. Shahin, 1994)

| PCI Value | Pavement Condition |
|---|---|
| 0-10 | Failed |
| 10-25 | Very Poor |
| 25-40 | Poor |
| 40-55 | Fair |
| 55-70 | Good |
| 70-85 | Very Good |
| 85-100 | Excellent |

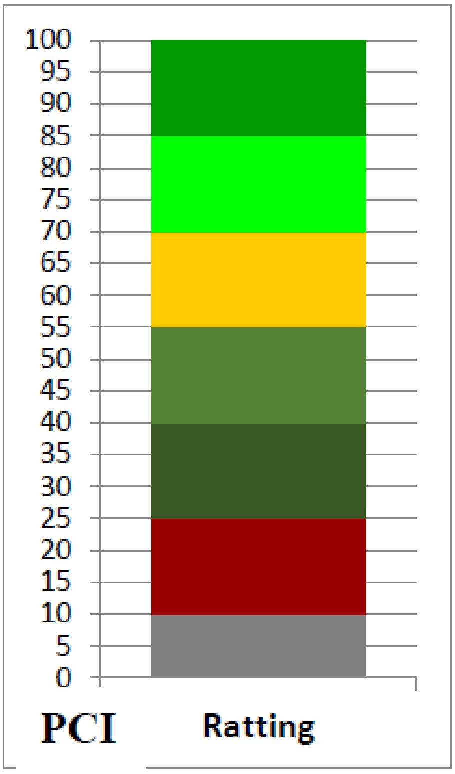

Figure 1. PCI Value

PCI Calculation Procedure

These steps and examples have been summarized from the ASTM Standards Yearbook (2011). Pavement Index Condition Determining Formula (PCI), After completing the survey, the data obtained were then calculated extensively and the percentage of damage according to the level and damage. The next step is to calculate the PCI value for each sample unit of the road segment, in Figure 1 will be presented how to determine the PCI value.

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1. Finding of Percentage of Damage

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 measured as a sample. Density can be expressed by the following equation:

Density = Ad,Ld/As x 100
Ad = Total area of damage type for each level of damage ($m^2$)
Ld = Total area of damage for each level of damage (m)
As = Total area of segment ($m^2$)

2. Determine Deduct Value

After obtaining the density value, then each damage is plotted into a deduct value graph according to the data.

3. Determine Value Q

The condition for finding the value of Q is that the value of the subtraction value is greater than 2 by using Interation. The subtraction values are sorted from largest to smallest. Previously, the value of the reduction in value was checked with the formula:

Mi = 1+(9/98) x (100 – HDVi)
Mi = Correction value for subtraction value
HDVi = Value of subtraction spread over one sample unit

If all the deduct values are greater than the Mi value, then it is subtracted from the deduct value by the Mi value, but if the deduct value is less than the Mi value, there is no need to subtract from the deduct value.\

4. Determine Corrected Deduct Value

Corrected Deduct Value is obtained from the curve of the relationship between the TDV value and the DV value by selecting the curve curve according to the number of individual deduct values that have a value greater than 2 which is also called the q value. If in the segment unit there is only one deduction value, then the TDV is used as a deduction or is used as a CDV see figure 2.

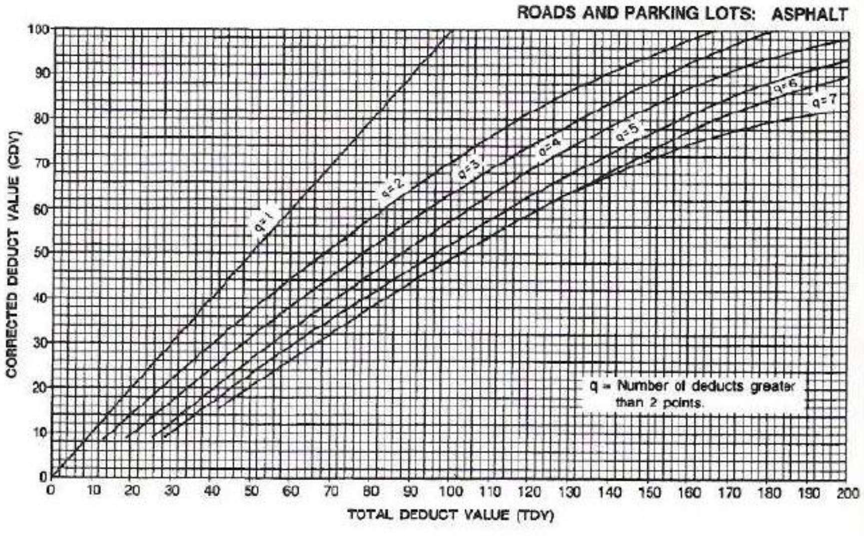


Figure 2. Graph of Corrected Deduct Value (M.Y. Shahin, 1994)

5. Determine Pavement Condition Index (PCI) Value

After obtaining the Corrected Deduct Value, the PCI value can be determined using the following formula:

PCI = 100 – CDV

After the PCI value is obtained, it can then be determined the rating of the sample unit being reviewed for graph plotting.

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## 2.2. Bina Marga Method

In the Bina Marga (BM) method, the types of damage that need to be considered when conducting a visual survey are surface roughness, holes, patches, cracks, grooves, and udders. The determination of the value of road conditions, see Table 2, is done by adding up each number and the value for each damage condition.

Table 2. Road damage condition value (General Bina Marga, 1997)

| Cracking Type | Value Damage |
|---|---|
| Alligator Cracking | 5 |
| Random Cracks | 4 |
| Transversal Cracking | 3 |
| Longitudinal Cracking | 1 |
| Nothing | 0 |
| Width | Value Damage |
| >2 mm | 3 |
| 1-2 mm | 2 |
| <1 mm | 1 |
| Nothing | 0 |
| Wide Damage | Value Damage |
| >30 % | 3 |
| 10-30 % | 2 |
| <10 % | 1 |
| Nothing | 0 |
| Rutting Depth | Value Damage |
| >20 mm | 7 |
| 11-20 mm | 5 |
| 6-10 mm | 3 |
| 0-5 mm | 1 |
| Nothing | 0 |
| Patching and utility cut patching | |
| Area | Value Damage |
| >30 % | 3 |
| 20 – 30 % | 2 |
| 10-20 % | 1 |
| <10 % | 0 |
| Surface Rough Type | Value Damage |
| Disintegration | 4 |
| Weathering / Ravelling | 3 |
| Rough | 2 |
| Bleeding | 1 |
| Close Texture | 0 |
| Depression | Value Damage |
| >5 / 100 m | 4 |
| 2-5 / 100 m | 2 |
| 0-2 / 100 m | 1 |
| Nothing | 0 |

After adding up each number of damage, then calculating the total number of damage obtained, see Table 3, for all types of damage and determine the value for the obtained road conditions.

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Table 3. Determination of the road condition value based on total damage (Direktorat Jendral Bina Marga, 1990)

| Total Value of Damage | Road Condition Value |
|---|---|
| 26-29 | 9 |
| 22-25 | 8 |
| 19-21 | 7 |
| 16-18 | 6 |
| 13-15 | 5 |
| 10-12 | 4 |
| 7-9 | 3 |
| 4-6 | 2 |
| 0-3 | 1 |

The calculation of the priority value of road conditions (Priority Order) is a function of the LHR class (average daily traffic) and the value of road conditions, which can be mathematically written as follows:

$$\textbf{Priority Value} = 17 - (\textbf{LHR} + \textbf{Road Condition Value})$$

1) Priority order 0 – 3, indicating that the road should be included in the improvement program.
2) The order of priority is 4 – 6, indicating that the road needs to be included in the regular maintenance program.
3) The order of priority > 7, indicates that the road is sufficient to be included in the routine maintenance program.

## 3. Result and Analysis

Table 4 Shows total damage and type of damage and Figure 3 shows a graph of the total damage

Tabel 4. Total and type of damage (Isradi et al., 2021)
Jumlah Kerusakan
Jalan Raya Narogong Cileungsi – Bantar Geabang (12Km)

| No | Jenis Kelamin | Jumlah Kerusakan | No | Jenis Kerusakan | Jumlah Kerusakan |
|---|---|---|---|---|---|
| 01 | Retak Buaya | 3 | 01 | Spalling Joint Cracks | 27 |
| 02 | Kegemukan | 2 | 02 | Corner Break | 33 |
| 03 | Keriting (Corrugation) | 2 | 03 | Linear Cracking | 60 |
| 04 | Amblas (Depression) | 3 | 04 | Divided Slab | 7 |
| 05 | Retak Pingir | 3 | 05 | Polished Agregate | 27 |
| 09 | Pinggir Jalan Turun | 3 | 09 | Large Patching | 9 |
| 11 | Tambalan | 5 | 11 | | |
| 12 | Pengausan Agregat | 5 | 12 | | |
| 13 | Lubang (Potholes) | 3 | 13 | | |
| 15 | Alur (Rutting) | 7 | 15 | | |
| 19 | Pelepasan Butir (Ravelling) | 7 | 19 | | |
| | Total Kerusakan | 43 | | Total Kerusakan | 163 |

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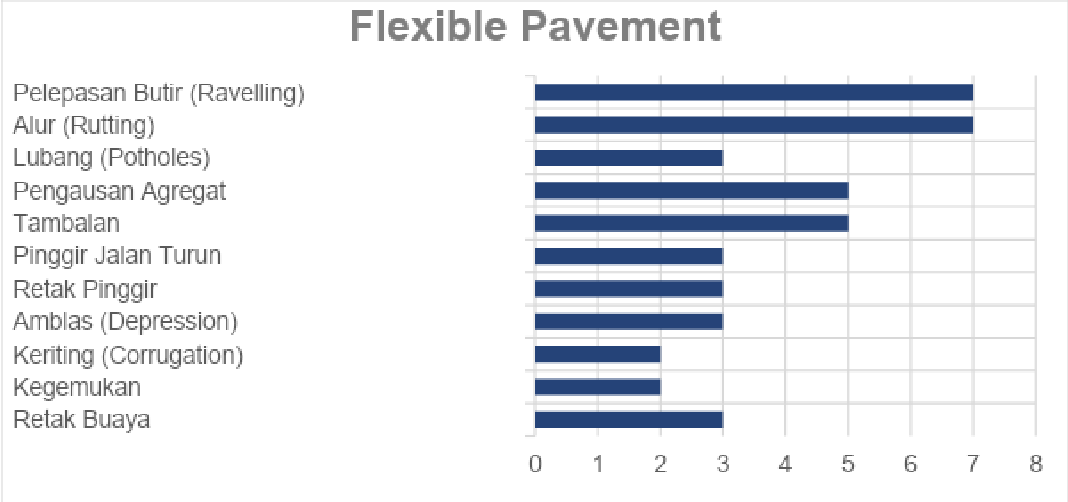


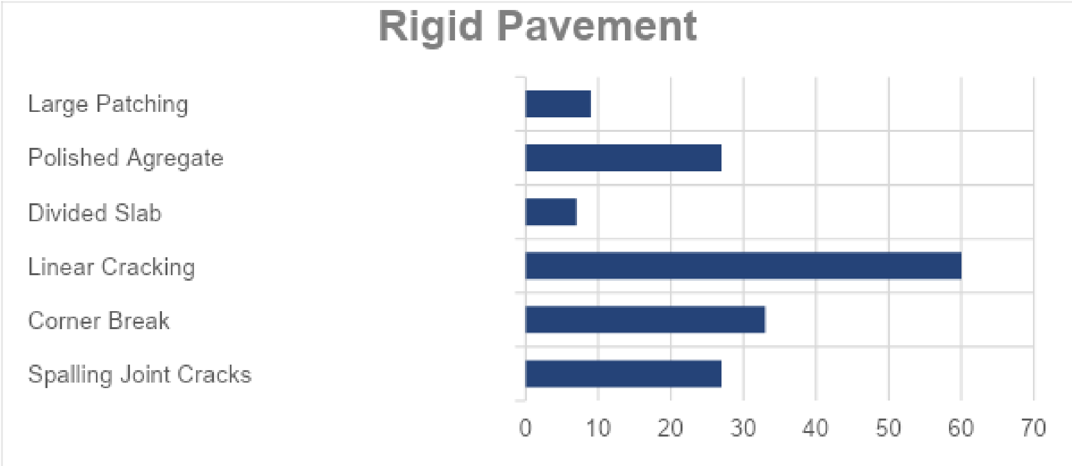


Figure 3. Graph of total damage

Based on calculations using the Pavement Condition Index (PCI) method, see Table 5, the condition values obtained for each segment.

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Tabel 5. Each segment damage condition value (Author's process, 2021)

| Segmen | STA | Distress Severity | TOTAL DAMAGE | DENSITY (%) | DEDUCT VALUE | TOTAL (DV) | PCI |
|---|---|---|---|---|---|---|---|
| | 0+000 - 0+100 | 15M | 4 | 0,8 | 17 | | |
| 1 | | 11L | 1,4 | 0,28 | 0 | 17 | 83 |
| | | 19L | 0,6 | 0,12 | 0 | | |
| | 11L | 11L | 3 | 0,6 | 3 | | |
| 2 | 07L | 07L | 4 | 0,8 | 5 | 50 | 55 |
| | 13L | 13L | 2 | 0,4 | 42 | | |
| | 01L | 01L | 1 | 0,2 | 5 | | |
| 3 | 12L | 12L | 3 | 0,6 | 0 | 8 | 92 |
| | 11L | 11L | 4,5 | 0,9 | 3 | | |
| | 12L | 12L | 4 | 0,8 | 0 | | |
| 4 | 11L | 11L | 3,5 | 0,7 | 3 | 11 | 89 |
| | 01L | 01L | 3 | 0,6 | 8 | | |
| | 12L | 12L | 50 | 10 | 3 | | |
| 5 | 11M | 11M | 2 | 0,4 | 6 | 11 | 89 |
| | 07L | 07L | 8 | 1,6 | 2 | | |
| | 12L | 12L | 15 | 3 | 0 | | |
| 6 | 05L | 05L | 4,4 | 0,8 | 2 | 20 | 80 |
| | 19H | 19H | 6,5 | 1,3 | 18 | | |
| | 06H | 06H | 4,5 | 0,9 | 18 | | |
| | 09H | 09H | 5 | 1 | 8 | | |
| 7 | 12M | 12M | 15 | 3 | 0 | 82 | 45 |
| | 13L | 13L | 2 | 0,4 | 43 | | |
| | 19H | 19H | 8 | 1,6 | 19 | | |
| | 19H | 19H | 400 | 80 | 75 | | |
| 8 | 09M | 09M | 6,5 | 13 | 10 | 95 | 5 |
| | 02H | 02H | 15,5 | 3,1 | 13 | | |
| | 05H | 05H | 10 | 20 | 5 | | |
| 1 | 03H | 03H | 15 | 30 | 37 | | |
| | 01H | 01H | 2,5 | 5 | 8 | 71 | 46 |
| | 01M | 01M | 10 | 2 | 30 | | |
| | 05H | 05H | 15 | 30 | 5 | | |
| 2 | 03H | 03H | 13 | 26 | 35 | 39 | 61 |
| | 01H | 01H | 2 | 4 | 8 | | |
| | 01H | 01H | 7 | 24 | 20 | | |
| 3 | 03H | 03H | 13 | 26 | 35 | 70 | 47 |
| | 02H | 02H | 2,5 | 5 | 15 | | |
| | | Amount | | | | 474 | 692 |
| | | | Value | | | | 69,2 |

Comparison of calculations between Bina Marga and PCI methods can be seen in Table 6.

Tabel 6. Comparison of Bina Marga Method and PCI Method

| Bina Marga Method | PCI Method |
|---|---|
| Conduct a LHR survey data | No LHR data Needed |
| In the analysis using a number table of damage condition, road condition and road class classification. | Analisys using graph of according to type of damage |
| The final result in order of road damage handling | The final result is the level of damage road |

## 4. Conclussion

1. The types of damage that occurred on the Narogong Cileungsi – Bantar Gebang highway were crocodile cracks, obesity, grain release, holes, transverse cracks, longitudinal cracks, groove cracks, random cracks, edge cracks, and patches.
2. The results of the research on the condition of the Narogong Highway (Cileungsi, Bantar Gebang) using the PCI method, the overall PCI value of the 830 m long road is 69.2 (Good)

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3. The results of the research using the Bina Marga method as a whole are included in the Periodic maintenance program
4. The results of the assessment of the Narogong Cileungsi - Bantar Gebang highway using the Bina Marga method and the PCI method turned out to produce relatively the same assessment, namely the road condition is still in moderate condition but requires maintenance and improvement.

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## Biography

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