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Analysis Of Urban Road Damage With Pavement Condition Index (PCI) And Surface Distress Index (SDI) Methods

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Abstract

Letjen S. Parman road is one of the urban roads with a length of 4.2 km located in West Jakarta area and is a primary arterial road with three two-way lanes divided, where the median is a toll road in the city of Jakarta. This study aims to evaluate road pavement conditions functionally and compare the value of road pavement conditions based on two methods, namely Pavement Condition Index (PCI) and Surface Distress Index (SDI) which are used as the basis for knowing the type of road maintenance handling. This study uses direct observation method in the field by conducting a visual survey of the condition of pavement, where the length of this road is divided into 42 segments with one segment is 100 meters. From the results of the road damage research Letjen. S. Parman using pavement condition index (PCI) and Surface Distress Index (SDI) method there are no significant differences in results. For pavement condition index (PCI) method get a percentage result of 90% with perfect value and 10% with excellent value while with Surface Distress Index (SDI) method get a percentage result of 96.5% with good category and 3.5% with medium category.

Keywords
Urban Roads, Letjen S.Parman Road, SDI, PCI, Road Damage

1. Introduction

DKI Jakarta province as the capital of Indonesia, has quite a problem of concern related to congestion. With the country's economy improving, infrastructure development also continues to increase. The overpass is one of the infrastructure that meets almost the corner of Jakarta. So far the construction of the overpass is more focused on solving traffic problems. The thing that has not been realized so far is that the addition of structures without visual impact assessment can damage the face of the city.

Road is a means of transportation that has a very important role in life including facilitating the economy and culture, the flow of distribution of goods and services, as access to connecting between one region and another and can improve the economy and living standards of the community.

Often, we still find damage to road infrastructure around us, such as residential neighborhood roads, roads and alleys, office and hotel / apartment neighborhood roads, roads that vehicles pass with light or heavy axle loads. This is usually exacerbated in the rainy season as it is at this time. At various levels of damage, road damage sometimes causes puddles, landslides and others.

This condition will certainly also interfere with comfort and endanger road users. Accidents often occur because motorists are unable to control and anticipate the damaged road, even many who also have the life of the rider. Road damage can also affect the pace of the economy' wheels. Damaged roads make the flow of goods and human transportation hampered, can also cause vehicle operational costs to increase due to damage to vehicle parts due to loads and bumpy and hollow roads.

One of the urban road segments that suffered damage was on the road Letjen S.Parman, located in the West Jakarta area. This road is a primary arterial road with 3 lanes 2 directions divided, where the median is a toll road in the city of Jakarta. This road is often passed by several types of vehicles from two-wheeled vehicles to four-wheeled vehicles (large), from searches that can be damaged on the road Letjen S.Parman, Pal Merah, West Jakarta makes motorists have to be careful and cause traffic density and cause congestion.

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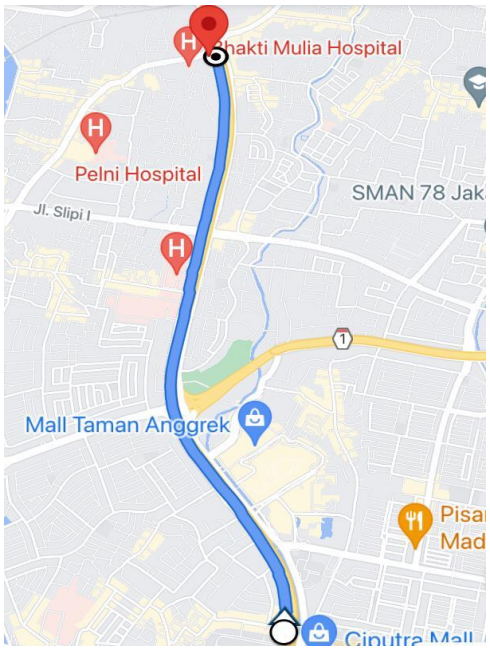
2. Research Methodology

2.1. General Description

This design was carried out at jalan S.Parman on STA 0+000 – 4+200 located in West Jakarta, DKI Jakarta. In this design, several stages are needed in the process such as, calculation of LHR (Daily Traffic), PCI calculation (Pavement Conditition Index) and SDI (Surface Disstres Index), and secondary data consisting of location maps and types of road construction, then data processing. A map of the design location can be seen in Figure 1 below.



Picture 1. Design Location Map

2.2. Average Daily Traffic

The traffic data obtained is first calculated to determine the age of the plan, traffic growth figures, with the formula:

$$\text{Average Daily Traffic} = \frac{\text{Total Traffic Durng Observation}}{\text{Length of observation time}}$$

2.3. PCI (Pavement Conditition 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 American 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. PCI levels are written in levels 0 – 100. (Hidayat & Santosa, 2018)

Picture 2. PCI value

1. Severity Level

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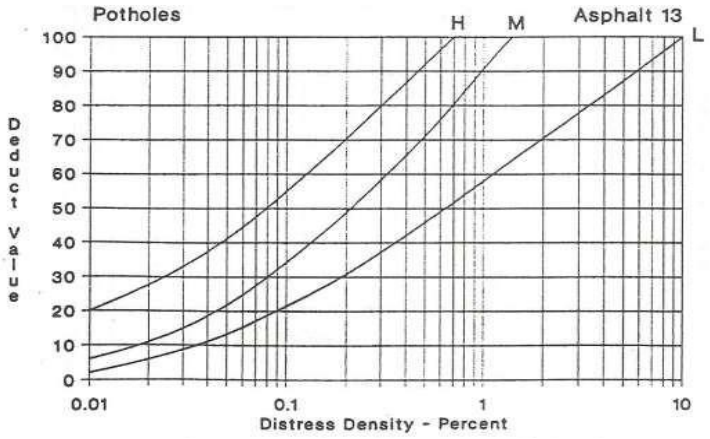
Severity level is the level of damage to each type of damage. The levels of damage used in PCI calculations are low severity level (L), medium severity level (M), and high severity level (H).

2. Density

Density or degree of damage is the percentage of area of a type of damage to the area of a segment unit measured in square meters or long meters. The density value of a type of damage is also distinguished based on the level of damage Density = (Ad / As) x 100%, or Density = (Ld / As) x 100%

3. Deduct Value

Deduct value is the subtraction value for each type of damage obtained from the relationship curve between density and deduct value. Deduct value is also distinguished by the level of damage for each type of damage. The following can be seen in Figure 3 for the Reduction Value of hole damage.



Picture 3. *Deduct Value* Ptoholes

4. Total Deduct Value (TDV)

Total Deduct Value (TDV) is the total deduct value of each type of damage and the level of damage present in each segment unit.

5. Corrected Deduct Value (CDV)

Corrected Deduct Value (CDV) is obtained from the relationship curve between the value of TDV and the value of CDV with the selection of curve curves according to the number of individual deduct values that have a value greater than 5.

2.4. SDI (Surface Disstres Index)

Surface Distress Index (SDI) is a scale of road performance obtained from visual observations of road damage that occurs in the field. Factors that determine the determination of the magnitude of SDI are the condition of cracks on the road surface from the total area and width of the crack flat, other damage conditions obtained from the number of holes per 100m length of road, as well as the depth of the former wheel / rutting. The value obtained at the examiner will then be calculated using the assessment standard by Bina Marga, (2011)

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Table 1. Assessment of Types of Damage to SDI

Penilaian Jenis Kerusakan SDI			
	Kategori	Nilai x	Nilai SDI[a-d]
Category Crack Area	None		
	< 10%	-	0
	10% - 30%	-	5
	> 30%	-	20
Category Crack Width	None	-	0
	< 1 mm	-	0
	1 – 3 mm	-	0
	> 3 mm	-	Hasil SDI[a] x2
Category Number of Holes	None	-	0
	<10 /100m	-	Result SDI[b] + 15
	10 – 50 /100m	-	Result SDI[b] + 75
	>50 /100m	-	Result SDI[b] + 225
Used Wheel Rating	None	0	0
	<1cm	0,5	Result SDI[c] + 5 x 0,5
	1-3cm	2	Result SDI[c] + 5 x 2
	>3	4	Result SDI[c] + 5 x 4

6. PCI Value

Determining the PCI value for each unit can be known PCI(s) = 100 – CDV, For the overall PCI value:
PCI = PCI Σ PCI(s)/N
Information:
PCI = Total Pavement Value
PCIs = PCI value for each segment unit or research unit
N = Number of sample units
The value obtained can indicate the pavement condition in the segment reviewed whether good, very good or even bad.

Table2. PCI Value

PCI Value	Condition
0 – 10	(Failed)
11 – 25	(Very Poor)
26 – 40	(Poor)
41 – 55	(Fair)
56 – 70	(Good)
71 – 85	(Very Good)
86 – 100	(Excellent)

Table 3. Standard Road Conditions

Road Conditions	SDI
Good	< 50
Medium	50 - 100
Lightly Broken	100 – 150
Heavily Broken	> 159

Table 4. Determination of Handling Type

SDI			
< 50	50 - 100	100 – 150	> 159
Routine Maintenance	Routine Maintenance	Periodic Maintenance	Improvement / Reconstruction

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3. Results and Analysis

3.1. Traffic Calculation

Average daily traffic data is required to plan the thickness of the pavement and analyze road capacity. Traffic data is obtained from the results of a direct survey for 3 days in 2021.

Table 5. AVERAGE DAILY TRAFFIC DATA

Time	Average SMP Vehicle in 1 Hour		
	Heavy Vehicle	Light Vehicle	Motorcycle
Tuesday, 27 April 2021	77,17	1879,5	3531,67
Thursday, 20 May 2021	74,84	2056,5	3917,17
Thursday, 27 May 2021	79,17	2451,5	4105

3.2. PCI (Pavement Condition Index)

Table 6. Pavement Condition Data in Segment 25

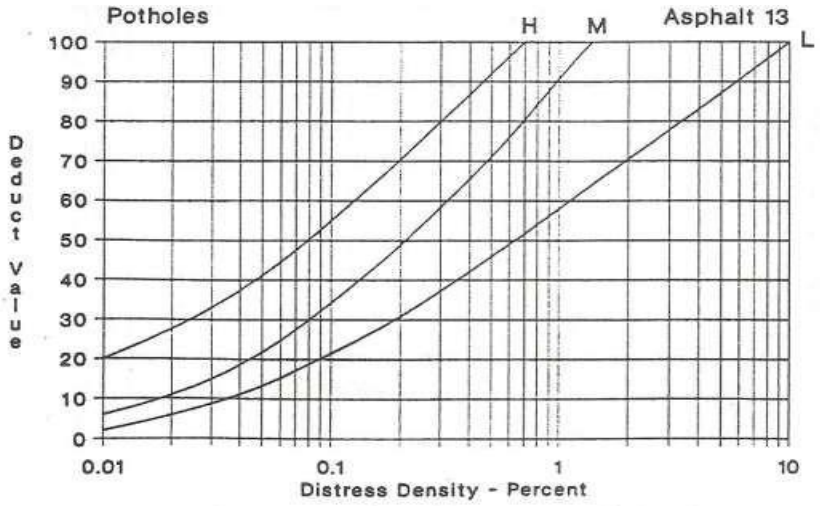
STA	Type of Damage	∑ Slab	Volume	Unit
2+400 - 2+500	3 L	2	0.03	m²
	5 L	2	0.98	m²

1. Density

$\frac{0.03}{4 \times 100} \times 100\% = 0{,}0075\%$

$\frac{0.98}{4 \times 100} \times 100\% = 0.245\%$

2. Deduct Value



Picture 4. Deduct Value Graph of Hole Damage

Hole Damage (3L) = 0,0075% , Deduct Value = 0

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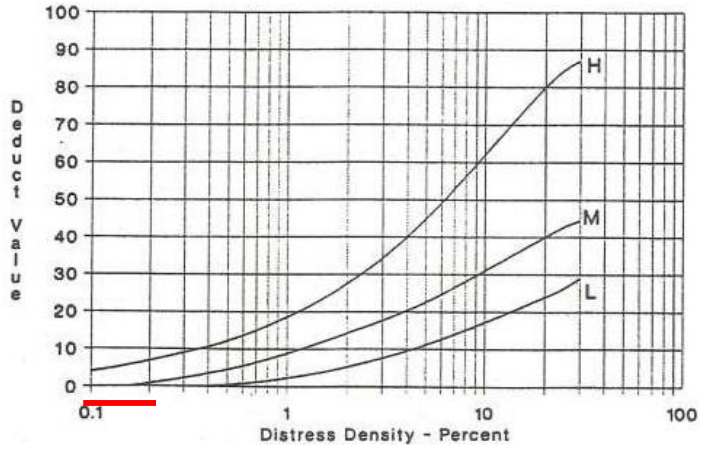


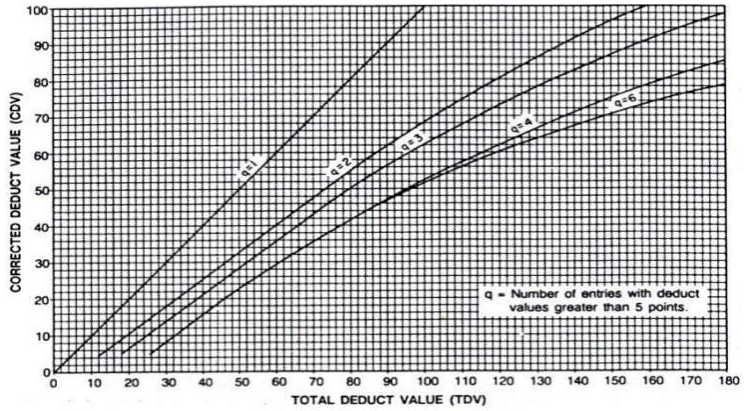
Picture 5. Deduct Value Graph of Hole Damage

Hole Damage (5L) = 0,245% , Deduct Value = 0

3. Total Deduct Value
4. Corrected Deduct Value

Table 7. Calculations of Deduct Value and Total Deduct Value

STA	Deduct Value		Total	q
1+700 - 1+800	0	0	0	0



Picture 6. Graph of relationships between TDV and CDV

a. Based on the graph above, the CDV result is = 0

5. PCI Value

PCI = 100 – CDV
= 100 – 0
= 100 (Excellent

3.3. SDI (Surface Disstres Index)

Table 8. Road Condition Data in Segment 25

STA	% AREA	WIDE CRACK	NUMBER OF HOLES	USED WHEEL
2+400 - 2+500	<10%	< 1 mm	1-5/100 m	1-3 cm

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Table 9. Road Condition Assessment Results

STA	CATEGORY	SDI VALUE	ROAD CONDITION	TYPE OF HANDLING
2+400 - 2+500	Wide Assessment of Cracks	5	GOOD	Routine Maintenance
	Crack Width Assessment	5		
	Hole Number Rating	20		
	Used Wheel Rating	30		
	SDI Value	30		

4. Types of Road Damage Handling

Table 10. Types of Road Damage Handling

Damage Type and Level	Management
Longitudinal and Transverse Crack	P3 Repair Method (Crack Coating) Mobilize equipment, workers and materials to the field. Clean the part to be handled with a water compressor, so that the road surface is clean and dry. Spray tack coat (0.2 liters/ m2 in the area to be repaired). Spread and flatten the concrete asphalt mixture on the entire marked area. Perform light compaction (1 - 2) tons until a flat surface and optimum density (density 95%).
Alligator Crack	P4 Repair Method (Crack Filling) Mobilize equipment, workers and materials to the field. Clean the part to be handled with a water compressor, so that the road surface is clean and dry. Fill the cracks with asphalt cut back 2 liters / m² using asphalt sprayer or with human power. Scatter coarse sand on cracks that have been filled with asphalt (10 mm thick) Compacts a minimum of 3 tracks with a baby roller.
Edge Cracking	P3 Repair Method (Crack Coating) Mobilize equipment, workers and materials to the field. Clean the part to be handled with a water compressor, so that the road surface is clean and dry. Spray tack coat (0.2 liters/ m2 in the area to be repaired). Spread and flatten the concrete asphalt mixture on the entire marked area. Perform light compaction (1 - 2) tons until a flat surface and optimum density (density 95%).
Rutting	P6 Repair Method (Alignment) Clean the part that will be handled with human power. Sprinkle a tack coat of 0.55 liters/m2. Sprinkle the concrete asphalt mixture then compact it until a flat surface is obtained. Compact with a baby roller (minimum 5 tracks).

5. Conclusion

Based on the results of the data analysis that has been done, several conclusions can be drawn found on the road section of Lt. Gen. S. Parman along 4.1850 km (Slipi - Grogol) among others:

1. Average vehicle smp / hour on the road Lt. Gen. S. Parman:

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Grain Release	P2 Repair Method (Local Asphalt Investment) Mobilize equipment, workers and materials to the field. Cleaning the part to be handled with the water compressor, the road surface should be clean and dry. Spray with hard asphalt as much as 1.5 kg / m2 and for cut back 1 liter / m 2. Scatter coarse sand or fine aggregates 5 mm to flat. e. Compacting pneumatic machines until a flat surface is obtained and has an optimal density (density of 95%).
Hole	P5 Repair Method (Hole Patching) Dig the material until it reaches the bottom layer. Clean the part that will be handled with human power. Spray the prime coat fastening suction layer with a dose of 0.5l iter/m2. Scatter and compact the concrete asphalt mixture until a flat surface is obtained. Compact with a baby roller (minimum 5 tracks).
Patching	Repair or replacement of patches throughout the depth for permanent repair and surface patching is carried out for temporary repair.
Joint Rreflection Crack	P3 Repair Method (Crack Coating) Mobilize equipment, workers and materials to the field. Clean the part to be handled with a water compressor, so that the road surface is clean and dry. Spray tack coat (0.2 liters/ m2 in the area to be repaired). Spread and flatten the concrete asphalt mixture on the entire marked area. Perform light compaction (1 - 2) tons until a flat surface and optimum density (density 95%).

a. On day 1 of April 27, 2021, 78 heavy vehicles (HVs), 1880 light vehicles (LV), and 3532 motorcycles (MC)
b. On the 2nd day of May 20, 2021, 75 heavy vehicles (HVs), 2057 light vehicles (LV), and 3918 motorcycles (MC)
c. On the 3rd day of May 27, 2021, 80 heavy vehicles (HVs), 2452 light vehicles (LV), and 4105 motorcycles (MC)

2. Types of damage to Lt. Gen. S. Parman's Road
    1) Using pci method there are 8 types of damage, namely, alligatorCrack by 0.9%, Patch by 72.8%, Hole by 16.1%, Edge Crack by 4.2%, Longitudinal Transverse Crack by 3.4%, Join Reflection Crack by 0.9%, Groove by 0.9%, item release by 0.9% with the largest percentage of damage is Patch damage.
    2) By using the SDI method, the results of research on the condition of the road segment Lt. Gen. S. Parman with the SDI method get the largest value, namely with a value of 75 and the smallest and most values, namely with a value of 22.5.
3. For comparison of road damage analysis Lt. Gen. S. Parman with PCI and SDI methods both showed the value of road damage with good conditions where with PCI method perfect condition 90% and very good condition 10% while with SDI method good condition 96.5% and medium condition 3.5%.
4. To handle the repair of the condition of the road by means of P2 repair method (Local Asphalt Investment) for grain release damage, P3 repair method (Crack Coating) for length and transverse cracking, edge cracking and joint reflection cracking, P4 repair method (Crack filling) for crocodile skin crack damage, P5 repair method (Hole Patching) for hole damage and P6 repair method (Alignment) for groove damage.

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Biographies

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Andri Irfan., is a Senior Lecturer of Civil Engineering and Planning. He completed the PhD at the Universitas Indonesia & Universidade do Minho with Sandwich Program Scholarship from the Directorate General of Higher Education and LPDP scholarship. He has been teaching for more than 19 years and much active to applied his knowledge in the project construction in Indonesia. His research interest ranges from pavement management system toadvanced data mining techniques for transportation engineering. He has published more than 50 papers in journals and2 books.

Amar Mufhidin., He was born in Majalengka on 16 June 1991. He is lecturer of some program study : pavement planning, road geometric planning, and transportation planning. He earned his Bachelor Degree in civil engineer fromIndonesian University of Education, and he earned his Master Degree in Civil Enginer with concentration in

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transportation from Bandung Institute of Technology. He has expertise certificate of road pavement from Lembaga Pengatur Jasa Konstuksi. And he is still active in road planning project in Indonesia.

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