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Analysis of Road Damage Repair Using SDI (Surface Distress Index) Method Case Study: KS. Tubun St. – Merpati St., Tegal City

Muhammad Alif Ridwan, M. Daffa Izzuddin, Raditya Faris Nailulloh, Dani Fitria Brilianti
Politeknik Keselamatan Transportasi Jalan Tegal Indonesia

ABSTRACT

Road damage is something that must be addressed immediately because roads play an important role such as connecting remote areas to economic centers, connecting public services, providing mobility for humans or goods, and other social activities that cross the KS Tubun - Merpati road, Tegal City. Using a quantitative approach, data were collected via surveys on the street, focusing on the road that have some crack or broken to collect the data that been using to analyze the category of road damage. This study aims to identify the types of damage on KS Tubun Road and Merpati Road along STA 0+000 to STA 0+1200 and calculate the total SDI value to determine the value of road pavement conditions using the Surface Distress Index (SDI) method. The results obtained for the analysis of the types of damage that occurred on Jalan KS Tubun and Jalan Merpati at STA 0+000 to STA 0+1200, based on the SDI method, there are elements of damage, namely edge damage of 9.87 m^2, vertical cracks of 7 m^2, longitudinal cracks of 3 m^2, holes with a total area of 8411.7m^2, patches of 4020.54 m^2, sloping areas of 48m^2, road depressions of 323m2, road fatness of 20m^2, road aggregate wear of 210m^2, and railroad crossings of 1960m^2. The results of the SDI calculation show that the road conditions on the KS Tubun and Jalan Merpati sections are in good condition.

Keywords: *SDI (Surface Distress Index), Road Damage, KS Tubun and Merpati Road, road condition handling*

Corresponding author
Name: Muhammad Alif Ridwan
Email: alifridwanpktj@gmail.com

INTRODUCTION

One of the most important land transportation infrastructures is roads. Roads have several functions such as connecting remote areas with economic centers, supporting the mobility of people and goods, and providing easy access to public services. This activity is certainly carried out continuously so that it puts a burden on the road which ultimately causes road damage if not handled properly (Wiro et al., 2019).

Road damage is a major obstacle to mobility and affects the economy. Road damage can be indicated by cracking, distortion, and disintegration (Yastawan et al., 2021). The explanation is as follows:

1. Alligator Cracking is a crack in the form of small polygons resembling crocodile skin. The cause of this damage is caused by non-standard pavement materials, surface weathering, and unstable base soil
2. Depression occurs due to the fall of the pavement surface layer at certain locations with or without cracks caused by the weight of vehicles that exceed the standard and due to the base soil settlement.
3. Patching and Utility Cut Patching is the covering of the pavement section that is undergoing repairs. Damage to the patch causes distortion, disintegration, cracking or peeling between the patch and the original pavement surface.
4. Potholes are cavities on the road surface caused by disintegration and loss of materials in the surface layer and foundation layer.
5. Edge Cracking occurs at the meeting of the edge of the pavement surface with the shoulder of the dirt road (unpaved shoulder) or also at the edge of the paved roadside with the surrounding soil.
6. Longitudinal Cracks occur if the asphalt layer is applied on a cement foundation layer including soil-cement and foundations with cement stability can crack due to reflection.
7. Transverse Cracks have two main causes in the form of reflection effects which are of course modeled in reflection cracks.
8. Rutting is a permanent deformation of the pavement layer due to traffic that is formed on tire tracks continuously which eventually forms grooves. (Belwa et al., 2024)

One method for analyzing the level of road damage is using the SDI (Surface Distress Index) method (Bina Marga, 1990). The SDI method is a direct assessment of road conditions through a road condition survey that produces an SDI value. The SDI method is the latest method for conducting road condition surveys in accordance with the 2011 Directorate General of Highways guidelines. The SDI method is carried out by measuring the width of cracks, average cracks widths, number of potholes and average of wheel rutting (Belwa et al., 2024).

This study aims to determine the type of damage, level of damage and type of repairs appropriate to the road on the KS Tubun - Merpati road section. Minor damages on the road sections if not repaired immediately will make the damage worse, such as road damage that occurred on Jalan KS Tubun and Jalan Merpati will cause inconvenience to road users so that repairs are needed. Jalan KS Tubun and Jalan Merpati are located in Tegal Selatan District, Tegal City. Both of these roads are two-lane, two-way and undivided roads (2/2 TB) with a total road length of 1.200 meters and a road width of 8 and 7 meters. Based on the results of a field survey of the level of traffic development crossing the road, the road conditions experienced a lot of minor damage and severe damage that occurred at STA 0+000 to STA 0+1200 such as cracks and holes.

METHOD

Research Location

This research using qualitative method with form of survey on the location. The research location was conducted on Jalan KS Tubun and Jalan Merpati, Tegal Selatan District, Tegal City. Both of these roads are two-lane, two-way and undivided roads (2/2 TB) with a total length of the road section reviewed being 1.2 km long and 8 m for KS Tubun road and 7 m for Merpati road meters wide (Figure 1).

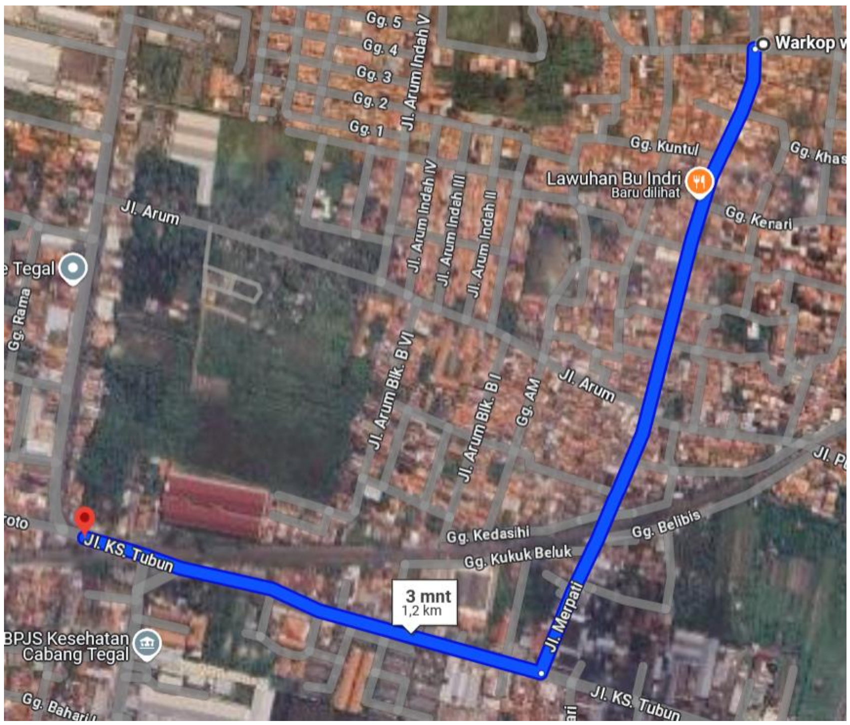

Figure 1 Road of KS. Tubun and Merpati

Data Collection

The study involved gathering field data, including both primary and secondary data. Primary data consisted of measurements of crack area, crack width, the number of potholes, and the depth of wheel rutting. Damage data were assessed by dividing the observed road into several segments, each 100 meters in length.

Primary Data

1. **Crack Area**
   The total area of various types of cracks found along the road is calculated according to the Road Maintenance Manual Bina Marga No. 03/MN/B/1983 issued by the Ministry of Public Works and Housing (PUPR). After determining the total damage area, it is compared to the total measured road area to calculate the percentage of damage.
2. **Crack Width**

The average width of all observed cracks along the road is calculated. Individual crack widths are summed and divided by the total number of cracks found on the road.

3. **Number of Potholes**
   The total number of potholes is counted within each predefined station along the road segment.
4. **Wheel Rutting Depth**
   Measurements of wheel rutting depths were taken on the pavement surface at each station. Since this damage may not occur at every station, the average rutting depth is calculated by dividing the total rut depth area by the number of ruts observed.
5. **Road Inventory Data**
   Road inventory data include geometric characteristics, such as road length, width, effective lane width, and more. Measurements were performed using tools like a walking measure or a tape measure. Data collection was performed per station, adjusted to the observed road conditions.

Secondary Data

Secondary data serve as supporting data to analyze the observed road damage. These include maps of the research area, road segment maps, road names and numbers, pavement types, and other relevant data.

Research Instruments

Research instruments include various tools needed for the study, such as:

- Writing materials
- Rulers
- Measuring tapes
- Walking measures
- Cameras/phones
- Crack scales
- Other supporting tools

Surface Distress Index (SDI)

The research utilized the Surface Distress Index (SDI) method as the primary reference for calculating road damage.

1. **Calculating Damage Area**
   The area of each type of road damage is calculated using the formula:

   $Ar = Pr \times Lr$

   $At = Pt \times Lt$

   Where:
   - Ar: Damage area
   - Pr: Damage length
   - Lr: Damage width
   - At: Total of road area

- Pt: Total of road length
- Lt: Total of road width

2. **Percentage of Damage**

Damage percentage is calculated using the formula:

$$\% \, r = Ar \, / \, At * 100\%$$

SDI Analysis

Calculating SDI_1

The SDI_1 value represents the percentage of road damage in relation to the total observed road. It is categorized as follows:

Table 2. 1 Table of Crack Area Assessment

No	Category	SDI_1 Value
1	None	-
2	<10%	5
3	10%–30%	20
4	>30%	40

Calculating SDI_2

The SDI_2 value is based on the average crack width at a single road station and categorized as follows:

Table 2. 2 Table of Crack Width Assessment

No	Category	SDI_2 Value
1	None	-
2	Fine <1 mm	-
3	Medium 1–3 mm	-
4	Wide >3 mm	SDI_1 * 2

Calculating SDI_3

SDI_3 is calculated by summing all potholes observed along each road station. Categories are as follows:

Table 2. 3 Table of assessment of the number of potholes on the road

No	Category	SDI_3 Value
1	None	-
2	<10/km	SDI_2 + 15
3	10–50/km	SDI_2 + 75

4	>50/km	SDI_2 + 225

Calculating SDI_4

The final SDI_4 value is calculated based on the average wheel rutting depth per road segment. The formula is:

Table 2. 4 Table of assessment of the depth caused by wheel rutting on the road

No	Category	X	SDI_4 Value
1	None	-	-
2	<10/km	0.5	$SDI_3 + 5 * X$
3	10–50/km	2	$SDI_3 + 5 * X$
4	>50/km	5	$SDI_3 + 4 * X$

Condition Assessment

Once SDI values are obtained for each station or road segment, they are compiled to assess the overall road condition. The SDI values determine the appropriate type of maintenance:

Table 2. 5 SDI categories and The Solution of Each Category

SDI			
<50	50 - 100	100 - 150	>150
Routine Maintenance	Routine Maintenance	Periodic Maintenance	Total Reconstruction

After identifying the road condition category based on the obtained SDI, the appropriate maintenance method can be determined according to the level of road damage.

FINDING AND DISCUSSION

RESEARCH RESULT

Table 3. 1 List of Road Damage

STATIONING		TYPES OF ROAD DAMAGE
0 + 000	0 + 100	PATCHING (2) POTHOLES (1)
0 + 100	0 + 200	RAILWAY CROSSING (1) POTHOLES (1) PATCHING (1) EDGE CRACKING (1)
0 + 200	0 + 300	POTHOLES (3)

0 + 300	0 + 400	-
0 + 400	0 + 500	-
0 + 500	0 + 600	PATCHING (2)
0 + 600	0 + 700	PATCHING (1) RAILWAY CROSSING (1)
0 +700	0 + 800	ROAD SPADE (1) PATCHING (1) ROAD AGGREGATE WEAR (1)
0 + 800	0 + 900	ROAD BASIN (2) ROAD OBESITY (1)
0 + 900	0 + 1000	LONGITUDINAL CRACK (1) PATCHING (1)
0 + 1000	0 + 1100	POTHOLES (1) VERTICAL CRACK (1)
0 + 1100	0 + 1200	-

Table 3. 2 Condition of the Road for Each Station

STATIONING		**CALCULATION OF SDI VALUE EACH 100 M**					
		CRACK AREA	**CRACK WIDTH**	**NUMBER OF POTHOLES**	**WHEEL RUTTING**	**SDI VALUE**	**CONDITION**
0 + 000	0 + 100	5	-	20	-	25	GOOD
0 + 100	0 + 200	40	-	55	-	95	MEDIUM
0 + 200	0 + 300	-	-	15	-	15	GOOD
0 + 300	0 + 400	-	-	-	-	0	GOOD
0 + 400	0 + 500	-	-	-	-	0	GOOD
0 + 500	0 + 600	-	-	-	-	0	GOOD
0 + 600	0 + 700	-	-	-	-	0	GOOD
0 + 700	0 + 800	-	-	-	-	0	GOOD
0 + 800	0 + 900	5	-	-	-	5	GOOD
0 + 900	0 + 1000	5	-	20	-	25	GOOD
0 + 1000	0 + 1100	-	-	-	-	0	GOOD
0 + 1100	0 + 1200	-	-	-	-	0	GOOD

(Source: Data Processing Results)

DISCUSSION

Table 3.2 shows the SDI value and road conditions from the results of data processing on road damage to the KS Tubun and Merpati Road sections, South Tegal District, Tegal City with the types of road damage being vertical cracks, longitudinal cracks, and side damage. The highest SDI value was obtained on KS Tubun Road at stations 0 +

100 to 0 + 200, which was 85. The cracks that occurred were edge damage with a damage area of 128.37%, resulting in an SDI 1 is 5. While the crack width ranged from 1-3 mm, resulting in an SDI 2 is 0. There was also 1 hole with a depth of 1.5 cm, resulting in an SDI 3 is 55 and no tire marks were found. The SDI value was totaled and obtained a value of 95. This is classified as medium condition.

The handling method for Jalan KS Tubun and Jalan Merpati in accordance with Road Preservation Management for Regional Road Network Management 2011 is routine maintenance because the highest SDI value obtained from the data processing process is 95.

CONCLUSION

The types of damage that occurred on the KS Tubun - Merpati Tegal City road section were edge damage of 9.87 m^2, vertical cracks of 7m^2, longitudinal cracks of 3m^2, holes with a total area of 8411.7m^2, patches of 4020.54 m^2, sloping areas of 48m^2, road depressions of 323m^2, road fatness of 20m^2, road aggregate wear of 210m^2, and railroad crossings of 1960m^2.

Meanwhile, for the value of road conditions based on the SDI value analysis, the entire stationing received a good category except for the stationing of 0+100 - 0+200 which received a moderate category. The handling needed for these two roads is routine maintenance

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