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Analysis of District Road Conditions in Waepotih Village, Maluku Province

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ABSTRACT

The Regency road section in Waepotih Village is a road section located in Waplau District, Maluku Province. This road section was completed in 2008. However, recently the road section has been damaged which makes people no longer feel comfortable when driving through this road. The purpose of the study was to identify the factors causing road damage and analyze the value of road conditions on the Regency Road section in Waepotih Village consisting of the left and right lanes using the SDI method. The results of direct analysis in the field, the road damage that occurred on the Regency road section in Waepotih Village was caused by the failure to build drainage channels on the road section. From the calculation results, the average results of the evaluation of damage to the Regency road section in Waepotih Village on the left lane were 11 segments, namely based on the Surface Distress Index Method, the SDI value for the left lane was 45.5 with good surface conditions. The percentage results based on the Surface Distress Index (SDI) Method were 45.5% of the pavement surface had good conditions, 54.5% of the pavement surface had moderate conditions. On the right lane there are 11 segments, namely based on the Surface Distress Index Method, the SDI value for the right lane is 27.3 with good surface conditions. The percentage results based on the Surface Distress Index (SDI) value are 27.3% of the surface has good conditions, 72.7% of the pavement surface has moderate conditions.

1. INTRODUCTION

Roads are an important part of transportation, because roads function as a link between one area and another. The existence of a road will accelerate the growth and development of an area, but this facility is often damaged because as an area develops, this facility is used more often. Roads are the means of transportation that are most often damaged, therefore it is necessary to review the types of road damage. The review of the types of damage carried out includes: density, level of road damage, and handling of road damage. It is very important to know how severe the structural condition of the damaged road is through this study. If the road is damaged without any handling, the road will be even more damaged. Usually roads often experience damage with types of damage such as cracks, potholes, grain release and collapse. Comfort and safety when driving will be reduced. According to Anugrah [1], in general the causes of road damage are various factors such as the planned age of the road that has been passed, puddles of water on the road surface that do not flow due to poor drainage, excessive traffic loads (overload) causing the road to have a shorter service life than planned. The Regency Road Section in Waepotih Village is a road section that connects Namniwel Airport as the gateway to Buru Regency with Waplau District. This road section was completed in 2008 to facilitate and improve the economy and community activities in Waepotih Village. This road section is damaged along 1.1 km of the total length of the road section, which is 4 km with a road width of 5.8 m. The damage occurred starting from Sta 0+000 – Sta 1+100. Along this road section there are residents' houses, and all residents' activities are also often carried out along this damaged road section. This road section is also not built with side channels or drainage as stipulated by the government in Government Regulation No. 34 of 2006 [2]. Article 34, concerning the useful space of the road includes the road body, roadside channels, and its safety threshold. Drainage functions to drain rainwater so that it does not inundate the road body. Because if the road body is flooded and when the water content in the soil has exceeded its optimum value, the bearing capacity of the soil will decrease. In these road conditions, vehicles still pass through, then there is a release of bonds between grains. This is what happened on the road section in Waepotih village due to the absence of roadside channels or drainage. Therefore, direct observation is needed to identify road damage, where the SDI (Surface Distress Index) method is used to calculate the value of the damage condition. The SDI method focuses on

identifying various types of damage such as cracks, holes, wavy surfaces, and other deformations. By measuring damage with SDI, road managers can determine the priority of handling based on the severity of the identified damage. This evaluation also extends the life of the road pavement in an efficient and targeted manner. Thus, the use of SDI provides great benefits in more effective road infrastructure management.

The purpose of the study was to identify the factors causing road damage and analyze the value of road conditions on the Regency Road section in Waepotih Village consisting of the left lane and the right lane using the SDI method. Analysis is very necessary to determine the condition of the road surface in Waepotih Village that is damaged and also what factors have the potential to damage the condition of the road surface and other parts of the road. Initial research on what factors influence road damage is by conducting a direct survey to the Regency Road in Waepotih Village by directly seeing the type of damage that occurs and what factors cause the road damage.

2. RESEARCH METHODOLOGY

A. Research Location

The research location is in Waepotih Village at Sta 0+000–Sta 1+100, Waplau District, Buru Regency, Maluku Province. The research location is as seen in Figure 1 and Figure 2.

Figure 1. Research location map

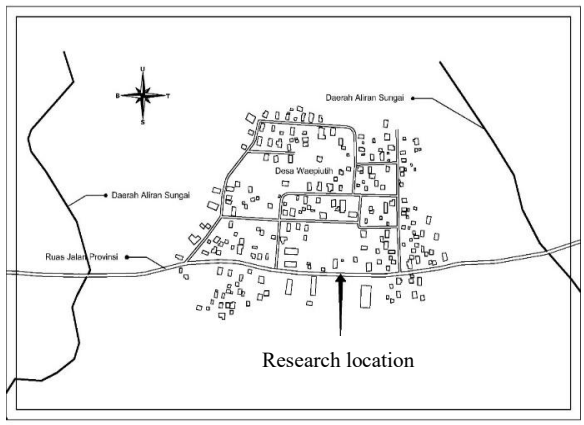

Figure 2. Road network map

B. Data types

1. Primary data
   a. Damage Dimension
   b. Length of road section
   c. Crack area
   d. Crack width
   e. Number of holes
   f. Wheel marks
2. Secondary data
   a. Previous research journals
   b. Location map

C. Data Collection Techniques

1. Library research method, or library research, is a research method that collects data and information by utilizing various library sources such as books, journals, articles, and other documents that are relevant to the research topic.
2. Field research method, or field research, is a research method that is carried out by collecting data directly from locations or situations that are relevant to the research topic.

D. Research Variables

In this study, two variables were used, namely independent variables and dependent variables. The independent variable (Independent variable) or variable X is a variable that is seen as the cause of the emergence of the dependent variable which is suspected as the result. While the dependent variable (Dependent variable) or variable Y is a variable (result) that is assumed, generally a condition that is to be expressed [4].

1. Independent variables, namely: Surface area of pavement damage, hole depth, size of crack gap, length of crack, etc.
2. Dependent variables, namely: Value of road damage conditions.

E. Analysis Method

The analysis method used to determine the factors causing damage [3] on road sections is as follows:

1. Analysis of road section damage index every 100 meters.
2. Assessment of road damage conditions using the SDI (Surface Distress Index) method.

F. Research Activity Flowchart

The research activities follow the flowchart in Figure 3.

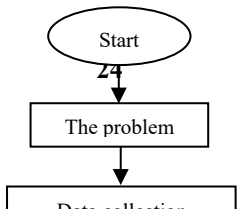

Figure 3. Research flow diagram

3. RESULTS AND DISCUSSION

A. Road Condition Survey Result Data Based on Surface Distress Index (SDI)

The road condition survey was conducted on the Regency Road section in Waepotih Village, starting point (KM 0+000) and ending point (KM 1+100) on the Regency Road section in Waepotih Village, with a total length of 4,000 meters. The segmentation is divided into 11 (eleven), each segment is 100 meters long. The description of the SDI data that has been measured on the Regency Road section in Waepotih Village shows variations in the types of damage to the pavement surface, namely: Subsidence, Cracks, Potholes. Surface damage dimension data can be described in Table 1 and Table 2.

Table 1. Road Damage Data for Waepotih Village, Segment 1–7 Left Lane

Segment	Location (KM)	Pavement Surface [7]				Cracked			Other damage				Shoulders, side channels, etc.				
		Arrangement	condition	Decline	additionan	Type	Wide	Wide	Number of Holes (L)	Hole Size (U)	Wheel Marks	Edge Damage	Shoulder Condition	Shoulder Surface	Side Channel Conditions	Slope Damage	Sidewalk
1	0+000 0+100	2	3	2	1	1	3	3	3	4	1	2	2	4	1	1	1
2	0+100 0+200	2	1	1	1	1	3	2	3	2	1	1	1	1	1	1	1
3	0+200 0+300	2	3	1	1	1	4	2	2	2	1	2	1	1	1	1	1
4	0+300 0+400	2	1	2	1	3	4	2	3	5	1	2	2	2	1	1	1
5	0+400 0+500	2	3	1	1	3	3	3	3	4	1	2	2	3	1	1	1
6	0+500 0+600	2	1	2	1	1	4	2	1	1	1	1	1	3	1	1	1
7	0+600 0+700	2	1	1	1	2	3	3	1	1	1	2	2	3	1	1	1

Table 1. Data on Road Damage in Waepotih Village, Segment 1–7 Left Lane (continued)

Segment	Location (KM)	Pavement Surface [7]				Cracked			Other damage				Shoulders, side channels, etc.				
		Arrangement	condition	Decline	additionan	Type	Wide	Wide	Number of Holes (L)	Hole Size (U)	Wheel Marks	Edge Damage	Shoulder Condition	Shoulder Surface	Side Channel Conditions	Slope Damage	Sidewalk
8	0+700 0+800	1	1	1	1	4	4	2	2	4	1	2	1	1	1	1	1
9	0+800 0+900	2	3	2	1	1	3	2	1	4	1	1	2	3	1	1	1
10	0+900 0+1000	2	4	2	1	1	3	2	1	1	1	2	2	3	1	1	1
11	0+1000 0+1100	2	3	1	1	4	4	3	2	4	1	1	2	1	1	1	1

Table 2. Road Damage Data for Waepotih Village District Segment 1 – 11 Right Lane

Segment	Location (KM)	Pavement Surface [7]				Cracked			Other damage				Shoulders, side channels, etc.				
		Arrangement	condition	Decline	additionan	Type	Wide	Wide	Number of Holes (L)	Hole Size (U)	Wheel Marks	Edge Damage	Shoulder Condition	Shoulder Surface	Side Channel Conditions	Slope Damage	Sidewalk
1	0+000 0+100	2	3	2	1	1	4	2	3	4	1	2	2	3	1	1	1
2	0+100 0+200	2	1	1	1	1	3	2	1	2	1	2	2	2	1	1	1
3	0+200 0+300	2	1	1	1	3	3	2	2	4	1	2	1	1	1	1	1
4	0+300 0+400	2	4	2	1	3	4	2	3	4	1	2	1	1	1	1	1
5	0+400 0+500	2	1	1	1	1	3	2	3	1	1	1	1	1	1	1	1
6	0+500 0+600	2	1	1	1	4	4	2	1	1	1	1	2	1	1	1	1
7	0+600 0+700	2	1	1	1	1	3	2	1	1	1	1	2	1	1	1	1
8	0+700 0+800	1	1	1	1	4	3	2	1	1	1	1	2	3	1	1	1
9	0+800 0+900	2	1	1	1	3	3	2	1	5	1	2	2	3	1	1	1
10	0+900 0+1000	2	4	1	1	1	3	2	1	4	1	1	1	1	1	1	1
11	0+1000 0+1100	2	1	1	1	4	3	2	1	1	1	1	1	1	1	1	1

B. Surface Distress Index (SDI) Data Analysis

Based on data from each road damage obtained from a visual survey in the field [8], the next step is to calculate the damage figures for each segment to determine the level of damage to the pavement surface based on the Surface Distress

Index (SDI) value [9]. Table 3 and Table 4 below are calculation tables for segments 1-11 of the left and right lanes.

Table 3. Analysis of SDI Identification Data Segment 1 – 11 Left Lane

Segment	Crack Area		Crack Width		Number of Holes		Wheel marks	
1	SDI_1 10% - 30%	20	SDI_2 1 - 5 mm	SDI_1	SDI_3 10 – 50/100 m	SDI_2 + 75	SDI_4	SDI_3
2	SDI_1 <10 %	5	SDI_2 1 – 5 mm	SDI_1	$SDI_3$10 – 50 /100 m	SDI_2 + 75	SDI_4	SDI_3
3	SDI_1 <10 %	5	SDI_2 >5 mm	SDI_1 × 2	SDI_3 <10/100 m	SDI_2 + 15	SDI_4	SDI_3
4	SDI_1 <10 %	5	SDI_2 >5 mm	SDI_1 × 2	SDI_3 10 – 50 /100 m	SDI_2 + 75	SDI_4	SDI_3
5	SDI_1 10% - 30%	20	SDI_2 1 – 5 mm	SDI	SDI_3 10 – 50 /100 m	SDI_2 + 75	SDI_4	SDI_3
6	SDI_1 <10 %	5	SDI_2 >5 mm	SDI_1 × 2	SDI_3	SDI_2	SDI_4	SDI_3
7	SDI_1 10% - 30%	20	SDI_2 1–5 mm	SDI_1	SDI_3	SDI_2	SDI_4	SDI_3
8	SDI_1 <10 %	5	SDI_2 >5 mm	SDI_1 × 2	SDI_3 <10/100 m	SDI_2 + 15	SDI_4	SDI_3
9	SDI_1 <10 %	5	SDI_2 1 – 5 mm	SDI_1	SDI_3	SDI_2	SDI_4	SDI_3
10	SDI_1 <10 %	5	SDI_2 1 – 5 mm	SDI_1	SDI_3	SDI_2	SDI_4	SDI_3
11	SDI_1 10 – 30%	20	SDI_2 >5 mm	SDI_1 × 2	SDI_3 <10/100 m	SDI_2 + 15	SDI_4	SDI_3

Table 4. Analysis of SDI Identification Data Segment 1 – 11 Right Lane

Segment	Crack Area		Crack Width		Number of Holes		Wheel marks	
1	SDI_1 <10 %	5	SDI_2 >5 mm	SDI_1 × 2	SDI_3 10 – 50 /100 m	SDI_2 + 75	SDI_4	SDI_3
2	SDI_1 <10 %	5	SDI_2 1 – 5 mm	SDI_1	SDI_3	SDI_2	SDI_4	SDI_3
3	SDI_1 <10 %	5	SDI_2 1 – 5 mm	SDI_1	SDI_3 <10/100 m	SDI_2 + 15	SDI_4	SDI_3
4	SDI_1 <10 %	5	SDI_2 >5 mm	SDI_1 × 2	SDI_3 10 – 50 /100 m	SDI_2 + 75	SDI_4	SDI_3
5	SDI_1 <10 %	5	SDI_2 1 – 5 mm	SDI_1	SDI_3 10 – 50 /100 m	SDI_2 + 75	SDI_4	SDI_3
6	SDI_1 <10 %	5	SDI_2 >5 mm	SDI_1 × 2	SDI_3	SDI_2	SDI_4	SDI_3
7	SDI_1 <10 %	5	SDI_2 1 – 5 mm	SDI_1	SDI_3	SDI_2	SDI_4	SDI_3
8	SDI_1 <10 %	5	SDI_2 1 – 5 mm	SDI_1	SDI_3	SDI_2	SDI_4	SDI_3
9	SDI_1 <10 %	5	SDI_2 1 – 5 mm	SDI_1	SDI_3	SDI_2	SDI_4	SDI_3
10	SDI_1 <10 %	5	SDI_2 1 – 5 mm	SDI_1	SDI_3	SDI_2	SDI_4	SDI_3
11	SDI_1 <10 %	5	SDI_2 1 – 5 mm	SDI_1	SDI_3	SDI_2	SDI_4	SDI_3

Table 5 and Table 6 are a recapitulation of the results of the SDI value analysis on Regency Roads in Waepotih Village.

Table 5. Analysis of SDI Values for Segments 1 – 11 Left Lane

Segment	Damage Calculation				SDI value	Surface Conditions
	SDI_1	SDI_2	SDI_3	SDI_4		
1	20	20	95	95	95	Currently
2	5	5	80	80	80	Currently
3	5	10	25	25	25	Good
4	5	10	85	85	85	Currently
5	20	20	95	95	95	Currently
6	5	10	10	10	10	Good
7	20	20	20	20	20	Good
8	5	10	25	25	25	Good
9	5	5	5	5	5	Good
10	5	5	5	5	5	Good
11	20	40	55	55	55	Currently
		Average			45.5	Good

Based on the analysis results [10] in Table 5, the SDI value obtained was 45.5 for the left lane with good surface conditions and Table 6 obtained an SDI value of 27.3 for the right lane with good surface conditions.

Table 6. Analysis of SDI Values for Segments 1 – 11 Right Lane

Segment	Damage Calculation				SDI value	Surface Conditions
	SDI_1	SDI_2	SDI_3	SDI_4		
1	5	5	80	80	80	Currently
2	5	5	5	5	5	Good
3	5	5	20	20	20	Good
4	5	5	80	80	80	Currently
5	5	5	80	80	80	Currently
6	5	10	10	10	10	Good
7	5	5	5	5	5	Good

8	5	5	5	5	5	Good
9	5	5	5	5	5	Good
10	5	5	5	5	5	Good
11	5	5	5	5	5	Good
		Average			27.3	Good

C. Discussion of Surface Distress Index (SDI) Results

The results of the identification of pavement conditions obtained an average SDI value for the left lane of 45.5 with good conditions and for the right lane of 27.3 with good surface conditions [5]. The percentage of pavement surface conditions based on the SDI value [6] can be seen in Table 7 and Table 8.

Table 7. Percentage of Surface Conditions on the Left Lane of Waepotih Village District Road

Surface condition	Number of Segments	Percentage %
Good	6	45.5
Currently	5	54.5
Lightly damaged	-	-
Heavily damaged	-	-
Amount	11	100

Table 8. Percentage of Surface Conditions on the Right Lane of Waepotih Village Road

Surface condition	Number of Segments	Percentage %
Good	8	27.3
Currently	3	72.7
Lightly damaged	-	-
Heavily damaged	-	-
Amount	11	100

Table 7 describes the surface of the district road for the left lane in good condition with a percentage of damage of 45.5% for 6 segments and moderate surface conditions with a percentage of 54.5% for 5 segments. Table 8 describes the surface of the district road for the right lane in good condition with a percentage of damage of 27.3% for 8 segments and moderate surface conditions with a percentage of 72.7% for 3 segments.

D. Identify the Cause of Damage

Damage based on the results of the SDI survey found that segments 11 were identified as having surface crack damage as described in Tables 9 and 10.

Table 9. Identification of Damage to Segments 1-11 of the Left Lane

Damage	Measurement results	Analysis Results Based on SDI Method	Types of Damage Visual Survey Results
Decline	Area of decline <10% Segment area 10	1. Failure of pavement 2. Poor surface layer material mix	Poor compaction during work results in worse settlement and damage.
Cracked	Width 1 – 5 mm and Crack area 10 – 30 % Segment Area 7. • Width >5 mm and Crack area <10% of Segment Area 8.	1. Fatigue on pavement surfaces 2. Inadequate pavement thickness 3. Excessive deflection on the pavement surface	1. Fatigue on the pavement surface that may be caused by the traffic loads that the surface can support. 2. Inadequate pavement thickness
Hole	• Diameter <0.5 m Depth <5 cm segments 1 and 3. • Diameter <0.5 m with Depth <5 cm segments 5 and 11	1. Material loss due to grooves, peeling and cracking. 2. The lifting of worn asphalt due to sticking to vehicle tires 3. Poor surface layer material mix.	1. Material is lost due to asphalt granules forming holes. 2. The impact of grooves, peeling and cracks that are not repaired immediately

Table 10. Identification of Damage to Segments 1-11 Right Lane

Damage	Measurement results	Analysis Results Based on SDI Method	Types of Damage Visual Survey Results
Cracked	Width 1 – 5 mm Crack area <10% Segment area 3. Width >5 mm Crack area <10% Segment area 6.	1. Fatigue on the pavement surface 2. Inadequate pavement thickness 3. Excessive deflection on the pavement surface	1. Fatigue on the pavement surface which may be caused by the traffic load that the surface can carry. 2. Inadequate pavement thickness.
Hole	• Diameter <0.5 m with Depth <5 cm segments 1 and 2. • Diameter <0.5 m with Depth <5 cm segments 3 and 4.	1. Loss of material due to grooves, peeling and cracking. 2. Lifting of worn asphalt due to sticking to vehicle tires. 3. Poor surface layer material mix..	1. Loss of material due to asphalt granules forming holes. 2. The impact of grooves, peeling and cracks that are not immediately repaired.

4. CONCLUSION AND SUGGESTIONS

A. Conclusion

1. The average results of the evaluation of damage to the Regency road sections in Waepotih Village on the left lane are 11 segments, namely based on the Surface Distress Index Method, the SDI value for the left lane is 45.5 with good surface conditions. The percentage results based on the Surface Distress Index (SDI) Method are 45.5% of the pavement surface is in good condition, 54.5% of the pavement surface is in moderate condition. On the right lane there are 11 segments, namely based on the Surface Distress Index Method, the SDI value for the right lane is 27.3 with good surface conditions. The percentage results based on the Surface Distress Index (SDI) value are 27.3% of the surface is in good condition, 72.7% of the pavement surface is in moderate condition.
2. Types of road damage on the Regency Road section in Waepotih Village based on the SDI (Surface Distress Index) method for the left lane are in the form of subsidence, cracks and holes caused by:
   a. Decrease
      Factors causing damage based on the SDI method: failure of the pavement & poor surface layer material mixture.
   b. Cracks
      Factors causing damage based on the SDI method: fatigue on the surface, inadequate pavement thickness & excessive deflection on the pavement surface.
   c. Holes
      Factors causing damage based on the SDI method: poor surface layer material mixture, lifting of the worn layer asphalt due to sticking to vehicle tires & loss of material due to grooves, peeling & cracking.

   Types of road damage on the Regency Road section in Waepotih Village based on the SDI (Surface Distress Index) method for the right lane in the form of subsidence, cracks and holes caused by:
   a. Cracks
      Factors causing damage based on the SDI method: fatigue on the pavement surface, inadequate pavement thickness & excessive deflection on the pavement surface.
   b. Holes
      Factors causing damage based on the SDI method: poor surface layer material mixture, lifting of the worn layer asphalt due to sticking to vehicle tires & loss of material due to grooves, peeling & cracks.

B. Suggestion

It is recommended to conduct a more detailed survey with additional data on the size of the hole and the width of other damage.

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