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Road Damage Analysis using Surface Distress Index (SDI) and Its Handling on Provincial Road Babat - Jombang (STA 7+000 - 12+500)

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ABSTRACT

The Babat - Jombang road is often traveled by highly loaded vehicles because there are large industries along this section. In addition, the road is damaged by weather and poor subgrade conditions. Thus, resulting in road damage that can interfere with user comfort. Therefore, road damage analysis research was conducted on Babat - Jombang Road (STA 7+000 - 12+500). Road damage analysis in this study using the SDI method. The SDI (Surface Distress Index) method is a road performance scale obtained from visual observations of road damage that occurs in the field. The SDI method is a method that produces an SDI value obtained from the percentage of crack area, crack width, number of holes per 100 m, and the depth of the ruts. From this research, the types of damage on Babat - Jombang Road (STA 7+000 - 12+500) are the hole damage area of 0.11%, longitudinal cracks of 12.05%, transverse cracks of 0.17%, edge cracks of 0.29%, crocodile skin cracks of 79, 66%, shoulder joint cracking by 0.0015%, ruts by 1.48%, bleeding by 1.1%, ravelling by 2.61%, surface layer flaking by 0.13%, patches by 0.26%, upheaval by 0.51%, shoving by 1.6%. Road condition assessment using SDI method shows 87.27% in good condition and 12.73% in moderate condition. Handling carried out is leveling, sealing, hot aggregate sprinkle, and patching holes.

Keywords: *Road Damage; SDI (Surface Distress Index) Method; Road Damage Management*

INTRODUCTION

Land transportation framework which incorporates all pieces of the street, including associating structures, correlative structures and gear planned for traffic, which is on the ground, over the ground, underneath the ground, or potentially water, or more the water surface, with the exception of rail streets, truck streets, and link streets[1].

Road damage can be caused by several factors, including water, weather, pavement construction materials, unstable subgrade conditions, poor compaction process on top of the subgrade and tonnage or load of heavy vehicles that exceed capacity and increasing vehicle volumes[2]. In Lamongan Regency, many roads suffer from minor to severe damage. Among the causes of road damage in Lamongan Regency is the access of heavy vehicles, such as trucks, buses, and other heavy vehicles, which cause constant high stress, causing the road to deteriorate. In addition to significant loads, roads in Lamongan Regency are damaged by weather and poor subgrade conditions[3]. As a result, road damage can disrupt the flow of logistics, and have an impact on the economy[4].

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Figure 1. Existing Conditions at the Research Location

Based on these conditions, a study was conducted to analyze road damage based on the SDI (Surface Distress Index) method. This research is expected to provide an assessment of road conditions. This research is also expected to provide a form of handling that must be done. The SDI method is a scale of road capability obtained through visual observation of road conditions in the field. This method can be used on flexible pavement, rigid pavement, gravel and soil. The results of each type of damage obtained can determine the condition of the road by accumulating each pavement damage value. If the damage value of the road is greater, the road condition is worse, which means it requires good damage management[5]. The SDI method has several advantages compared to the PCI (Pavement Condition Index), IRI (International Roughness Index), and Bina Marga method shown in table 1.

Table 1. Advantages of the SDI Method

SDI Method	**PCI Method**
Damage types are more common, making it easier to identify damage [6]	There is too much risk when collecting data because there are too many types of damage, so identifying damage is prone to error[6].
SDI Method	**IRI Method**
SDI method of direct measurement is done in the field so that the resulting value tends to be close to the situation in the field[7].	IRI values obtained tend to be less close to the situation in the field, because the reading of the unevenness value is slightly delayed from the actual distance, also because the IRI value only reads the unevenness of the road surface as seen by the vehicle's wheels [7].
SDI Method	**Bina Marga Method**
SDI method is more efficient in assessing and calculating the cost of road damage maintenance[8].	SDI method is less efficient in assessing and calculating road damage maintenance costs[8] .

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METHOD

The SDI (Surface Distress Index) method was used to conduct a road damage analysis on the Babat-Jombang road. A road performance scale called the SDI method is made by looking at road damage in the field and making visual observations of it. [9]. The road defects considered in this method are crack area, crack width, and number of potholes per 100 m, as well as the depth of ruts. There are several assessment categories needed to determine the road condition score according to the SDI method

1. Cracked area category assessment is shown in table 2

Table 2. The assessment of crack area categories (Bina Marga 2011)

No	Crack Area Category	SDI[a]
1	None	-
2	<10%	5
3	10%-30%	20
4	>30%	40

2. The crack width category assessment is shown in table 3

Table 3. The crack width category assessment (Bina Marga 2011)

No	Crack width Category	SDI[b]
1	None	-
2	Fine <1 mm	-
3	Medium 1 mm - 3 mm	-
4	Width > 3 mm	SDI[a] x 2

3. The number of holes category assessment is shown in the table 4

Table 4. The number of holes category assessment (Bina Marga 2011)

No	Category Number of Holes	SDI[c]
1	None	-
2	<10 per 100 m	SDI[b] + 15
3	10 - 50 per 100 m	SDI[b] + 75
4	>50 per 100 m	SDI[b] + 225

4. Ruts depth category assessment is shown in the table 5

Table 5. The assessment of rut depth categories (Bina Marga 2011)

No	Wheel Ruts depth category	SDI[d]
1	None	-
2	<1 cm deep	SDI[c] + 5 x 0,5
3	1 - 3 cm deep	SDI[c] + 5 x 2
4	>50 per 100 m	SDI[c] + 5 x 4

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5. Road condition assessment according to SDI method is shown in the following table 6

Table 6. Road condition assessment according to SDI method (Bina Marga 2011)

No	Road Condition	SDI Value
1	Good	<50
2	Medium	50 - 100
3	Lightly Damaged	100 - 150
4	Heavy Damage	>150

After obtaining the SDI^a, SDI^b, SDI^c and SDI^d values from each segment, the largest value of the four values is taken, then the road condition value for each segment can be determined according to table 6.
According to Road Preservation Management for Regional Road Network Management 2011, the type of treatment according to the SDI method is shown in the table 7

Table 7. Handling type according to SDI method (Road Preservation Management for Regional Road Network Management 2011)

No	Handling Type	SDI Value
1	Maintenance Routine	<50
2	Maintenance Routine	50 - 100
3	Maintenance Periodic	100 - 150
4	Road Improvement or Road Reconstruction	>150

RESULTS AND DISCUSSION

The types of damage that occur based on direct observations on Jalan Raya Babat - Jombang (STA 7+000 - 12+500) are potholes, longitudinal cracks, transverse cracks, edge cracks, crocodile skin cracks, joint cracks, ruts (grooves), fatness (Bleeding), ravelling, surface layer peeling, patch damage, seepage, and shoving (13 types of road damage). An example of road damage at the study site is shown in the figure 2

Figure 2. Damage (a) Potholes, (b) Crocodile Skin Cracks (observation result)

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Figure 3. Damage to rut depth (observation result)

The number of types of road damage per segment on the babat - jombang highway (STA 7+000 - 12+500) is presented in Figure 4 as follows.

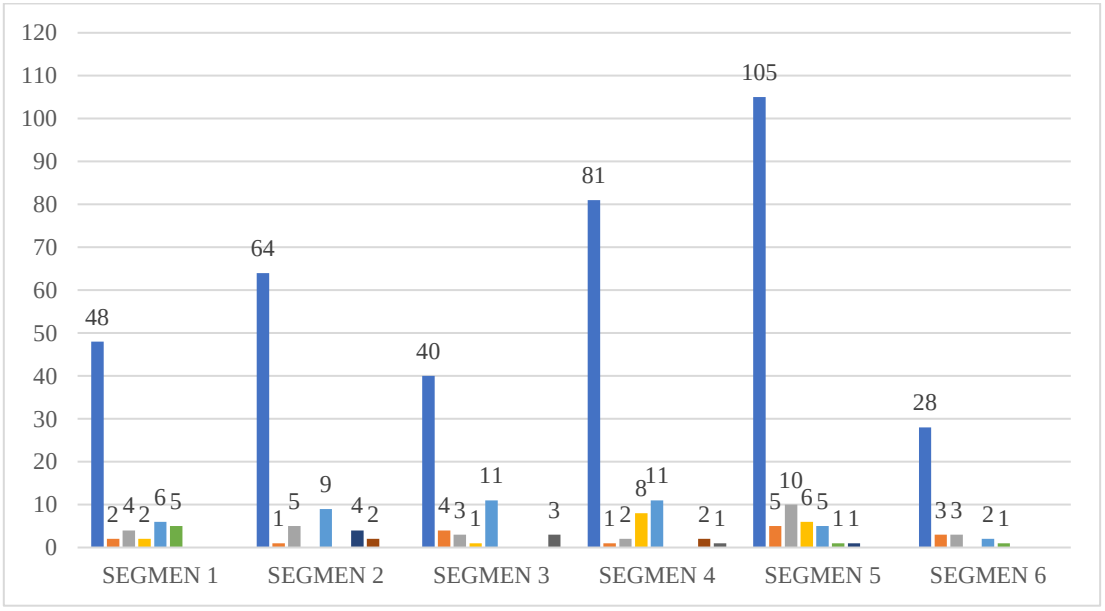

Figure 4. Number of road defect types per segment

Based on Figure 4, the most common type of road damage is crack damage. Thus making crack damage the most influential damage on road condition assessment based on the SDI method.

The SDI value of Jalan Raya Babat - Jombang STA 7+000 - 12+500 is presented in table 8.

Table 8. SDI Value Babat - Jombang Highway STA 7+000 - 12+500

Segment	Station	SDI[a]	SDI[b]	SDI[c]	SDI[d]	total SDI value	road conditions
1	7+000 - 7+100	5	10	10	10	10	Good
	7+100 - 7+200	5	10	10	10	10	Good
	7+200 - 7+300	5	10	10	10	10	Good
	7+300 - 7+400	5	10	10	10	10	Good
	7+400 - 7+500	5	10	25	25	25	Good
	7+500 - 7+600	5	10	25	25	25	Good
	7+600 - 7+700	5	10	25	25	25	Good

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	7+700 - 7+800	5	10	10	20	20	Good
	7+800 - 7+900	5	10	10	10	10	Good
	7+900 - 8+000	5	10	10	10	10	Good
2	8+000 - 8+100	5	10	25	25	25	Good
	8+100 - 8+200	5	10	10	10	10	Good
	8+200 - 8+300	5	10	10	10	10	Good
	8+300 - 8+400	5	10	10	10	10	Good
	8+400 - 8+500	5	10	10	10	10	Good
	8+500 - 8+600	5	10	25	25	25	Good
	8+600 - 8+700	5	10	25	35	35	Good
	8+700 - 8+800	5	10	10	10	10	Good
	8+800 - 8+900	5	10	10	10	10	Good
	8+900 - 9+000	5	10	10	10	10	Good
3	9+000 - 9+100	5	10	10	20	20	Good
	9+100 - 9+200	5	10	10	10	10	Good
	9+200 - 9+300	0	0	0	0	0	Good
	9+300 - 9+400	5	10	10	10	10	Good
	9+400 - 9+500	5	10	10	10	10	Good
	9+500 - 9+600	5	10	25	35	35	Good
	9+600 - 9+700	0	0	0	0	0	Good
	9+700 - 9+800	5	10	25	25	25	Good
	9+800 - 9+900	5	10	10	20	20	Good
	9+900 - 10+000	5	10	10	10	10	Good
4	10+000 - 10+100	5	10	25	25	25	Good
	10+100 - 10+200	5	10	10	10	10	Good
	10+200 - 10+300	20	40	55	55	55	Good
	10+300 - 10+400	5	10	10	20	20	Medium
	10+400 - 10+500	5	10	10	10	10	Good
	10+500 - 10+600	5	10	10	10	10	Good
	10+600 - 10+700	5	10	10	10	10	Good
	10+700 - 10+800	20	40	40	40	40	Good
	10+800 - 10+900	20	40	40	40	40	Good
	10+900 - 11+000	5	10	10	10	10	Good
5	11+000 - 11+100	20	40	40	50	50	Medium
	11+100 - 11+200	20	40	55	55	55	Medium
	11+200 - 11+300	20	40	55	65	65	Medium
	11+300 - 11+400	20	40	55	55	55	Medium
	11+400 - 11+500	5	10	10	20	20	Good
	11+500 - 11+600	20	40	55	55	55	Medium
	11+600 - 11+700	20	40	40	50	50	Medium
	11+700 - 11+800	5	10	10	10	10	Good
	11+800 - 11+900	5	10	10	10	10	Good
	11+900 - 12+000	5	10	25	25	25	Good
6	12+000 - 12+100	5	10	25	35	35	Good
	12+100 - 12+200	5	10	10	10	10	Good
	12+200 - 12+300	5	10	25	25	25	Good
	12+300 - 12+400	5	10	10	10	10	Good
	12+400 - 12+500	5	10	25	25	25	Good

Based on the table above, the road conditions on the babat - jombang road (STA 7+000-12+500) 48 STA are in good condition because they produce SDI values less than 50 and 7

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STA are in moderate condition because they produce SDI values between 50-100 (based on table 7).

Routine maintenance according to Ministerial Regulation No. 13 of 2011 is adjusted to the road damage that occurs on Jalan Raya Babat - Jombang STA 7+000 - 12+500. presented in table 9 as follows [10]

Table 9. Form of Handling on Babat - Jombang Highway STA 7+000-12+500

STA	Road Conditions	Damage Occured	Treatment
7+000-10+200, 10+300-11+000, 11+400-11+500, and 11+700-12+500	Good	Hole	Hole Patching
		Crocodile Skin Crack	Hole Patching
		Longitudinal Cracks Edge Cracks Transverse Cracks Shoulder Joint Cracks	Sealing
		Ruts grooves Grain Exfoliation Shoving	Leveling
		Seepage Patches Surface Layer Exfoliation	Leveling
		Bleeding	Hot aggregate sprinkle
10+200-10+300, 11+000-11+400, and 11+500-11+700	Medium	Holes	Hole Patching
		Crocodile Skin Crack	Hole Patching
		Longitudinal Cracks Edge Crack	Sealing
		Grooves Grain Flaking Shoving Patches	Leveling

CONCLUSION

From this research, it is obtained that the type of damage on Babat - Jombang Road (STA 7+000 - 12+500) is the area of damage to holes of 0.11%, longitudinal cracks of 12.05%, transverse cracks of 0.17%, edge cracks of 0.29%, crocodile skin cracks of 79, 66%, shoulder joint cracking of 0.0015%, ruts of 1.48%, bleeding of 1.1%, ravelling of 2.61%, surface layer

flaking of 0.13%, patches of 0.26%, seepage of 0.51%, shoving of 1.6%. Assessment of road conditions using the SDI method shows 87.27% in good condition and 12.73% in moderate condition. Handling that must be done immediately on Babat - Jombang Road (STA 7+000 - 12+500) is leveling, sealing, hot aggregate sprinkle, and patching holes with priority handling prioritized for roads with moderate conditions that require routine maintenance.

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