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EVALUATION OF THE LEVEL DAMAGE OF FLEXIBLE PAVEMENT ON THE SINGOSARI – RANDU AGUNG HIGHWAY MALANG REGENCY

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ABSTRACT

Singosari – Randu Agung Highway, Malang Regency, is a road as a national road and have a road functions as an arterial primary. This road segment is one of the roads that have a heavy volume of vehicles, due to excessive repetitive traffic loads (overloading), then resulting for damages surface layer and a decrease in the road quality. Based on that cased, this study have a purpose to evaluate the condition of road pavement and determine the value of road pavement conditions based on the Surface Distress Index (SDI) method and International Roughness Index (IRI) method which is used as a basis for determined alternative treatment that need to be done. Visual pavement condition assessment along 4 km was obtained by conducting field surveys with a form refers to Bina Marga Method (001-01/M/BM/2011). The result of the evaluation found that road damge such as holes, longitudinal crack, alligator crack, block crack, and transverse crack. Based on the road conditions that have been evaluated, obtained results with 63% in good condition along 2.5 km, 35% in medium condition along 1.4 km and 3% in light damage condition along 0.1 km. The type of the treatment for the routine road maintenance consist of patching holes and filler cracks.

Keywords : flexible pavement, road damage, Singosari – Randu Agung highway

1. INTRODUCTION

A road is part of an entire road and its auxiliary buildings and fixtures used for public traffic, located at ground level, above and below ground level and/or water level, except rail roads and cable roads (Peraturan Pemerintah No.30 Tahun 2021).

Damage to road infrastructure that is burdened by high and repeated traffic volumes will result in a decrease in road quality. This can be seen from the condition of the road surface, both structural and functional conditions that have been damaged (Agus Suswadi, 2008).

One of the cases of damage to this flexible pavement occurred on the Singosari – Randu Agung Highway, Malang Regency. Singosari – Randu Agung Highway, Malang Regency is a national road that functions as a primary arterial road. This section of road is one of the road sections with a very high volume of vehicles, because it is often passed from small to large vehicles of fairly high intensity. Even on this road section, there are often several vehicles that doing Over Dimension Over Loading or commonly called ODOL.

This phenomenon is a violation of freight transport in Indonesia, which has become a very serious problem. Over Dimension Over Loading is a situation where a vehicle carries a load that exceeds the specified load and the dimensions of the carrier are not in accordance with the production standards and provisions (Berita Kajian Pengendalian *Over Dimensi Over Loading)*. The result of ODOL is the causes of flexible pavement damages on this road, in which the Singosari – Randu Agung Highway, Malang Regency is a road that connects Malang Regency with Pasuruan Regency. The number of good transport vehicles that commit ODOL violations causes excessive recurrent traffic load (overloading), then resulted in damage to the surface layer and a decrease in road quality on the Singosari – Randu Agung Highway Malang Regency.

With vehicles commit ODOL offences, the resulting damage to the flexible pavement surface can lead to an increase in traffic accidents on this section of road, it is necessary to plan alternative treatment and proper repairs by evaluation of the level damge of flexible pavement on the singosari – randu agung highway malang regency using the

road damage analysis method, i.e Surface Distress Index Method (SDI), International Roughness Index (IRI) and determine alternative treatment that needs to be done to restore comfort in driving on this section of the road.

Study Location

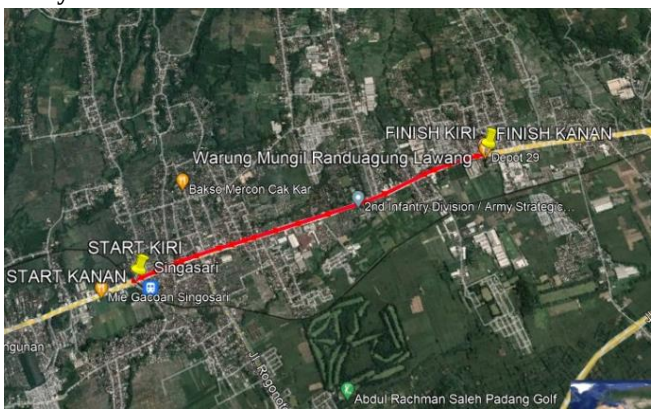

Figure 1. Study Location
Source: Google Earth

2. METHOD

In analysing the data in this study, there are several steps that need to be taken, i.e surveying the field, analysing data using the Surface Distress Index (SDI) and International Roighness Index (IRI) Method and determining the form of road damage handling

A. Surface Distress Index Method (SDI) and International Roughness Index (IRI) Data Analysis Procedure

The steps in analysing road damage using the Surface Distress Index (SDI) and International Roughness Index (IRI) method are as follows:

1) Define road type and road class
2) Calculate the average daily traffic (LHR) for the surveyed road and assign a road class value.
3) Collect survey data obtained in the field by filling out the survey form with the damage conditions found on the observed road.
4) After the survey form is filled in, the data is then entered into Microsoft Excel with the Road Condition Survey (SKJ) programme to calculate the SDI value and from the value, the form of treatment can be determined. According to Bina Marga 2011 SKJ to calculate the amount of SDI value, only 4 elements are needed which are used as support, namely: % crack area, average crack width, number of holes/km and average depth of wheel rutting.

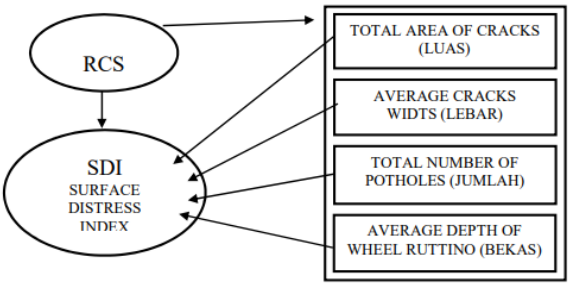

Figure 2. SDI Method Calculation
Source: Bina Marga, 2011

Table 1 determining SDI 1 (Crack area)

Table 1. Crack Area Assessment

No	Crack Area Category	SDI^1 Value
1	None	-
2	< 10%	5
3	10 - 30 %	20
4	> 30 %	40

Source: Bina Marga, 2011

Table 2 determining SDI 2 (Crack width)

Table 2. Crack Width Assessment

No	Crack Width Category	SDI^2 Value
1	None	SDI^1
2	< 1 mm (soft)	SDI^1
3	1 - 3 mm (medium)	SDI^1
4	>3 mm (wide)	SDI^1 x 2

Source: Bina Marga, 2011

Table 3 determining SDI 3 (Number of holes)

Table 3. Number of Holes Assessment

No	Number of Holes	SDI^3 Value
1	None	-
2	< 10/100 m	SDI^2 + 15
3	10 -50/100 m	SDI^2 + 75
4	> 50/100 m	SDI^2 + 225

Source: Bina Marga, 2011

Table 4 determining SDI 4 (Rutting depth/ ruts)

Table 4. Rutting Depth Assessment

No	Rutting Depth	SDI^4 Value
1	None	-
2	< 1 cm	SDI^3 + 5 x 0,5
3	1 - 3 cm	SDI^3 + 5 x 2
4	> 3 cm	SDI^3 + 5 x 4

Source: Bina Marga, 2011

5) Conduct an IRI survey to determine the unevenness of the road surface, using the Roadroid application on a

cellphone to determine the condition of the road surface according to the IRI value obtained.

Table 5. Surface Type and IRI Value

No	IRI Value	Surface Type	Description
1	< 4	Asphalt	Very good
2	4 - 8	Asphalt	Good-fair
3	8 - 12	Asphalt	Fair-poor
4	12 - 16	Asphalt	Poor-bad
5	16 - 20	Asphalt	Bad
6	≥ 20	Asphalt	Very Bad
7	Any	Unsealed	Unsealed

Source: Bina Marga, 2011

6) Sum up each result for all types of damage, and assign a road condition score. The greater the cumulative damage result, the greater the road condition score, which means the road is in poorer condition and requires better maintenance.

Table 6. Road Condition Assessment based on SDI and IRI Value

IRI Value (m/km)	SDI Value			
	< 50	50 - 100	100 - 150	> 150
< 4	Good	Medium	Medium	Light Damage
4 - 8	Medium	Medium	Light Damage	Light Damage
8 - 12	Light Damage	Light Damage	Heavy Damage	Heavy Damage
> 12	Heavy Damage	Heavy Damage	Heavy Damage	Heavy Damage

Source: Bina Marga, 2011

7) After the road condition values have been analysed, the researcher can determine the type of treatment.

Table 7. Treatment Type based on SDI and IRI Value

IRI Value (m/km)	SDI Value			
	< 50	50 - 100	100 - 150	> 150
< 4	Routine Maintenance	Routine Maintenance	Periodic Maintenance	Upgrade/Reconstruction
4 - 8	Periodic Maintenance	Periodic Maintenance	Periodic Maintenance	Upgrade/Reconstruction
8 - 12	Periodic Maintenance	Periodic Maintenance	Periodic Maintenance	Upgrade/Reconstruction
> 12	Upgrade/Reconstruction	Upgrade/Reconstruction	Upgrade/Reconstruction	Upgrade/Reconstruction

Source: Bina Marga, 2011

B. Damage Treatment

The treatment of road damage studied refers to the Bina Marga Method (001-02/M/BM/2011) and the Regulation of the Minister of Public Works and Public Housing Number 03 of 2011 concerning Procedures for Maintenance and Surveillance of Roads. Damage treatment in this study only handles repairs to non-structural pavements.

C. Flowchart

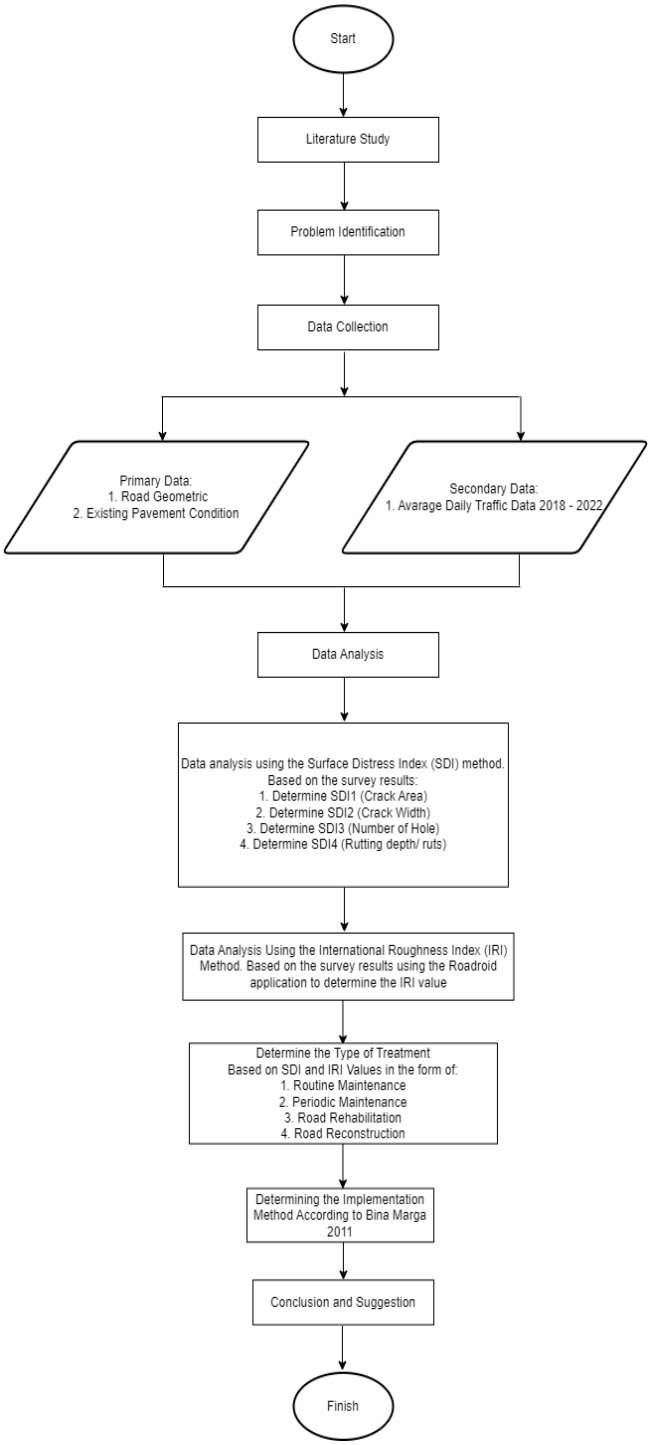

Figure 3. Research Flowchart

3. RESULT AND DISCUSSION

A. Research Result

Based on the problems and research methods carried out, the survey results are obtained which will then be included in the discussion, so that the type and level of damage can be identified in accordance with existing conditions.

B. Road Damage Data

Table 8. Example of Damage Data

NO	STA	POSITION		DAMAGE CATEGORY	MEASUREMENT						DESCRIPTION
		LEFT	RIGHT		P (m1)	L (m1)	D (m1)	A (m1)	V (m3)	% crack area	
34	3-300 + 3+400	√		Hole	0.4	0.21	0.02	0.084	0.00168	116%	2 damages
		√		Alligator Crack	33	3.5		115.5			
35	3+400 - 3+500	√		Longitudinal Crack	10	0.6		6		44%	2 damages
			√	Alligator Crack	13.4	2.85		38.19			

Source: Survey Result

At STA. 3+300 – 3+400 obtained 2 types of damage with details of 1 point of damage with holes and 1 point of damage to alligator cracks, and at STA. 3+400 – 3+500 didapatkan 2 types of damage with details of 1 point of damage to longitudinal crack and 1 point of damage to alligator cracks.

C. Road Condition Assessment

The assessment of road conditions in this study was by the Surface Distress Index method and International Roughness Index to obtain the results of damage conditions that occur on the Singosari - Randu Agung Highway, Malang Regency.

1) Road Damage Condition Analysis

Table 9. Analysis Results using SDI and IRI Method

SEGMENT	CALCULATION OF SDI VALUE PER 100 m				SDI VALUE	IRI VALUE	ROAD CONDITION	TREATMENT TYPE
	CRACK AREA	CRACK WIDTH	NUMBER OF HOLE	RUTS				
1	5	10	0	0	10	1.3	Good	Routine Maintenance
2	0	0	0	0	0	2.8	Good	Routine Maintenance
3	5	10	25	0	25	1.9	Good	Routine Maintenance
4	5	10	25	0	25	3.5	Good	Routine Maintenance
5	5	10	0	0	10	2.2	Good	Routine Maintenance
6	5	10	25	0	25	2	Good	Routine Maintenance
7	5	10	25	0	25	2.1	Medium	Routine Maintenance
8	5	10	0	0	10	2.1	Good	Routine Maintenance
9	0	0	0	0	0	4.2	Medium	Routine Maintenance
10	5	10	25	0	25	1.4	Good	Routine Maintenance
11	5	10	25	0	25	5	Medium	Routine Maintenance
12	5	10	25	0	25	5.5	Medium	Routine Maintenance
13	5	10	0	0	10	4	Medium	Routine Maintenance
14	5	10	0	0	10	4.6	Medium	Routine Maintenance
15	5	10	0	0	10	2.1	Good	Routine Maintenance
16	5	10	0	0	10	2.6	Good	Routine Maintenance
17	5	10	25	0	25	2	Good	Routine Maintenance
18	0	0	0	0	0	1.7	Good	Routine Maintenance
19	0	0	0	0	0	1.7	Good	Routine Maintenance
20	0	0	0	0	0	4.5	Medium	Routine Maintenance
21	5	10	0	0	10	3	Good	Routine Maintenance
22	5	10	0	0	10	2.1	Good	Routine Maintenance
23	20	20	40	0	40	5	Good	Routine Maintenance
24	20	40	55	0	55	4.1	Medium	Routine Maintenance
25	5	10	25	0	25	1.6	Good	Routine Maintenance
26	5	10	25	0	25	2.4	Good	Routine Maintenance
27	20	40	0	0	40	1.6	Good	Routine Maintenance
28	20	40	55	0	55	1.8	Medium	Routine Maintenance
29	5	10	25	0	25	2	Good	Routine Maintenance
30	20	40	0	0	40	1.6	Good	Routine Maintenance
31	40	80	0	0	80	5.4	Medium	Routine Maintenance
32	40	80	0	0	80	2.1	Medium	Routine Maintenance
33	5	10	0	0	10	3.9	Good	Routine Maintenance
34	40	80	95	0	95	1.7	Medium	Routine Maintenance
35	40	80	0	0	80	1.3	Medium	Routine Maintenance
36	40	80	0	0	80	9.6	Light Damage	Periodic Maintenance
37	20	40	0	0	40	2.3	Good	Routine Maintenance
38	0	0	0	0	0	1.9	Good	Routine Maintenance
39	0	0	0	0	0	3.2	Good	Routine Maintenance
40	20	40	0	0	40	4.1	Good	Routine Maintenance

Source: Calculation Result

2) Results Percentage of Road Damage Condition

The results of analysis road pavement conditions using the Surface Distress Index (SDI) and International Roughness Index (IRI) methods can also be seen in percentage form. The percentage of pavement conditions on segment 1 to segment 40 of the road section can be seen in table 10 below:

Table 10. Percentage of Road Pavement Condition

CONDITIONS	ROAD LENGTH (KM)	PERCENTAGE (%)
GOOD	2.5	63%
MEDIUM	1.4	35%
LIGHT DAMAGE	0.1	3%
HEAVY DAMAGE	0	0%
TOTAL	**4**	**100%**

Source: Calculation Result

The condition of the pavement damage level on each segment can be seen in the following figure. Based on the level of damage, damage treatment for roads in good, medium and light damage condition is carried out routine maintenance and periodic maintenance in the form of pacthing and crack filler.

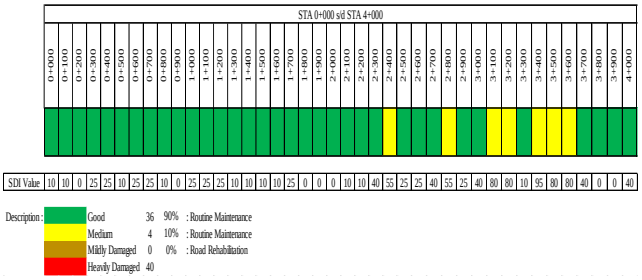

Figure 4. Road Ploating Results
Source: Calculation Result

D. Pavement Condition Treatment

Based on the analysis of road damage that has been described in the previous section, has obtained the type of road maintenance in the form of routine road maintenance. Based on Standard Repair for Routine Maintenance of Roads Bina Marga Method 2011, the treatment results for the Singosari - Randu Agung Highway Malang Regency have been obtained in the following table:

Table 11. Example of Treatment Type

STA		Damage Category	Damage Area (m^2)	Treatment Type
From	To			
1	2	3	4	6
3+300	3+400	Hole	0,084	P5 Patching
		Alligator Crack	115,5	P4 Crack Filler
3+400	3+500	Longitudinal Crack	6	P4 Crack Filler
		Alligator Crack	38,19	P4 Crack Filler

Source: Calculation Result

4. CONCLUSION

Based on the data and results of the analysis on the calculation of the Evaluation of the Level Damage of Flexible Pavement on Singosari – Randu Agung Highway Malang Regency, the following conclusions were obtained:

1. On Singosari - Randu Agung Highway there are several types of damage such as holes, longitudinal cracks, alligator cracks, block cracks, and transverse cracks. The calculation results show that the road condition on this section is 63% in good condition along 2.5 km, 35% in medium condition along 1.4 km and 3% in light damage condition along 0.1 km.
2. The form of of treatment that needs to be done on this road section is routine maintenance, in the form of patching holes and filler cracks.

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