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ANALYSIS OF ROAD DAMAGE USING THE SURFACE DISTRESS INDEX (SDI) METHOD ON THE GRESIK-SURABAYA ROAD SECTION KM. 4+900 TO KM. 7+700

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Abstract- *This Gresik-Surabaya road section is located north of Surabaya City. The road is under the authority of the East Java-Bali National Road Implementation Center. The Gresik-Surabaya road section is one of the connecting accesses between Surabaya City and Gresik Regency, which has damage to the road body. Overloaded heavy vehicles often pass through the road, which can cause damage to the road surface and cause problems such as decreased speed and travel time, as well as threaten the safety of road users or cause accidents. The purpose of the research on the Gresik-Surabaya road section, km. 4 + 900 to km. 7+ 700, is to find the value of the Surface Distrees Index (SDI) on a 2.8 km long study. The SDI method is carried out by sampling data with visual surveys using a road damage survey form (SKJ) or what is commonly called a Road Condition Survey (RCS), which is divided every 100 meters. So that the results obtained on the Gresik Surabaya road section, East Java, from segments 11 to 18 and continued on segments 26 to 28, the damage that is enough to get a large SDI value is the ruts. While in segments 2, 3, 5, and 6, the damage that gets the largest SDI value with moderate damage classification is cracking. The dominating road damage on Gresik Road, Surabaya, from Km 4+900 to Km 7+700, or from segment 1 to segment 28, is ruts and cracks. In measuring the pavement on the surface of the Gresik-Surabaya road along 2800 meters, which is divided into 28 segments, the SDI value is obtained as follows: Moderate SDI values are obtained in segment 2 with a SDI value of 75, Segment 3 with a SDI value of 60, segment 5 with a SDI value of 55, and segment 6 with a SDI value of 55. Good SDI value is obtained in segment 1 with SDI value 15, segment 4 with SDI value 25, segment 7 and 8 with SDI value 25, segment 9 with SDI value 10, segment 10 with SDI value 25, segment 11 to 18 with SDI value 20, segment 19 to 22 with SDI value 0, segment 23 and 24 with SDI value 15, segment 25 with SDI value 10, and segment 26 to 28 with SDI value 35.*

Keywords: Connecting access, Overloaded heavy vehicles, Road Damage, Surface Distress Index Method.

INTRODUCTION

Increasing economic needs and rapid community movement have consequences or duties for both central and regional governments to accelerate the provision and maintenance of transportation infrastructure in the form of good roads and bridges. Considering this, the post-construction policy of infrastructure becomes more significant. This is due to the difficulties involved in the maintenance, rehabilitation and management of the existing road network so that it can continue to be used properly. In this context, road infrastructure that is burdened by high and repetitive traffic volumes will lead to road deterioration. This deterioration can be observed through the deteriorated condition of the road surface, both structural and functional. Therefore, it is important to monitor the condition of the road surface and other road parts to determine the damage that has occurred. Monitoring the condition of the road surface is important as it provides an indication of the extent of the existing damage. This information is invaluable in planning and implementing maintenance, rehabilitation and road network management activities. By regularly monitoring road surface conditions, the government can identify emerging problems and take the necessary steps to improve and maintain the quality of road infrastructure.

Through effective monitoring, the government can optimize available resources for better road maintenance. By knowing the condition of the damaged road surface, corrective actions can be taken in a timely and efficient manner. This will have a positive impact on traffic flow, road user safety, and overall transportation efficiency.

In order to maintain good road infrastructure, the government needs to conduct continuous monitoring of road surface conditions. This monitoring should be done using appropriate methods and technology, so that the information obtained is accurate and reliable. Thus, post-construction policies for transportation infrastructure are important in maintaining road quality and ensuring the smooth running of an efficient transportation system.

Initial research on the condition of the road surface is conducted by conducting a visual survey, which means looking at and analyzing the damage based on the type and level of damage to be used as a basis for carrying out maintenance and repair activities. Assessment to determine and classify the type and level of pavement damage and determine the value of pavement condition by finding the Surface Ditress Index (SDI) value. Assessment of pavement condition is the most important aspect in terms of determining road maintenance and repair activities. To assess the condition of the pavement, it is necessary to first determine the type of damage, the cause, and the level of damage that occurs. The importance of good pavement construction conditions is sought to be able to meet traffic requirements and structural requirements. Traffic requirements, namely flexible pavement construction in terms of traffic safety and comfort, must meet the following requirements: a flat surface, a fairly rigid surface, a fairly smooth surface, and a non-glossy surface.

This paper investigates the problem of road damage on the Gresik-Surabaya road section, from km 4+900 to km 7+700. This research was conducted through a visual inspection of the road condition, with the aim of evaluating the extent of the damage and determining the necessary countermeasures to be implemented. Road condition inspection is conducted using the visual method, which involves direct observation of the road surface and other key sections. In this study, the focus is on the 2.8-kilometer Gresik-Surabaya road section, which is divided into segments. The results of the road condition inspection will provide an overview of the level of damage, such as structural or functional damage. This information is important in determining the treatment measures that should be implemented to repair the damage. By analyzing the results of the road condition inspection, appropriate countermeasures can be determined. These include measures such as structural repair of the road, repair of the road surface, replacement or repair of damaged road elements, or implementation of other solutions according to the type and extent of damage found. This study aims to provide concrete recommendations to relevant parties, both central and local governments, in an effort to address road damage on the Gresik-Surabaya section. By knowing the level of existing damage, effective and efficient actions can be taken to improve road infrastructure, keep road users safe, and improve the quality of transportation in the region.

RESEARCH METHODS

Measurement of road surface damage carried out on Jl. Gresik (Surabaya) along 2800 meters on February 27, 2022 The data collection method is direct observation or visual condition survey, followed by data calculation using calculations based on the parameters of the Surface Distress Index (SDI) method. With a total measurement length of 2800 meters and an area of each segment of 1400 m2 (100 m x 14 m). Assessment of road surface damage uses primary data obtained from direct observation in the field with parameters such as the area of cracks in each segment, crack width, number of holes, and vehicle ruts. Cross section of Gresik Surabaya road segments 1 to 28 from Km 4+900 to Km 7+700 With a total width of the Road Property Area (DMJ) of 18.8 meters, a road width of 14 meters, a sidewalk width of 1.2 meters, and a channel width of 1 meter.

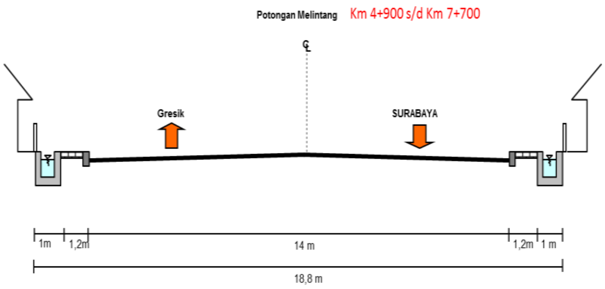

Figure 1 Cross section of Jl. Gresik Km 4+900 to Km 7+700
(source: PPK 3.4 Prov Jatim data)

Figures 2 and 3 are the conditions of the Gresik Km 4+900 road section located on Jalan Kalianak, Kalianak village, Asemrowo sub-district. The photo of the condition was taken on February 27, 2022, precisely at the beginning of a road condition survey on the road section. It can be seen from the photo that a lot of water is stagnant on the road body, indicating that the road is uneven. Therefore, a road condition survey can be carried out using the Surface Distress Index (SDI) method. Damage also occurs in the final segment of the study, namely Km 7 + 700.

It can be seen in the photo image of the KM 7 + 700 Gresik road condition that damage occurs on asphalt pavement, namely holes, puddles, and ruts. With these conditions, a road condition survey can be carried out using the Surface Distress Index (SDI) method.

Figure 2.
Condition of Jl. Gresik Km 4+900

Figure 3.
Condition of Jl. Gresik KM 7+700

The primary data required in this study are:

1. Total area of cracks The total area of cracks was obtained during the survey by measuring the length and width of crack damage on the pavement surface in each road segment. Furthermore, the crack area data is divided by the road area per segment and then multiplied by 100% to get the percentage of area per station or segment.
2. Average crack width (width) The average crack width is obtained by directly measuring the width of the crack damage. Then the data for each crack width is summed up and then divided by the amount of crack damage in one station or segment so that the average width of crack damage is obtained.
3. Total number of potholes (total) Data The number of holes, or the total number of potholes, is obtained by calculating the number of holes in one road station.
4. Average depth of wheel rutting (used) Data collection for the average depth of wheels or average depth of ruts is done by measuring the depth of each rut on the pavement per station. Furthermore, the number of depths is summed up and divided by the amount of damage from the ruts so that the average depth of wheel data is obtained.
5. Road geometry data In this part of the survey, road geometry data was collected in the form of the length and width of the road section of Sidassimpang Three by measuring directly in the field.

In this study, the authors will conduct an analysis of the Surface Distress Index (SDI) given by Bina Marga in 2011, where the data analyzed is data obtained from the survey results. The data used in the SDI analysis are: percentage of crack area, average crack width, number of holes per km, and average depth of ruts. Data Analysis includes these steps: (1) Analyzing the SDI 1 value (crack area); (2) Analyzing the value of SDI 2 (crack width); (3) Analyzing SDI value 3 (number of holes); (4) Analyzing SDI 4 value (depth of ruts).

RESULTS AND DISCUSSIONS

Assessment of the pavement surface of the Gresik, Surabaya road is carried out because of a decrease in road quality marked by damage. Damage assessment uses the Surface Distress Index (SDI) method by conducting a road condition survey using the following parameters: crack area, crack width, number of holes, and ruts. So as to get the value of the Gresik, Surabaya road pavement on segment 1 to segment 5 at Km 4 + 900 to km 5 + 400 based on the SDI method is in table 1.

Table 1. Survey and Calculation Data Segment 1 - Segment 5

SEGMENT	PARAMETER *SURFACE DISTRESS INDEX (SDI)*			
	Total area of cracks ($SDI_{1)}$)	Average cracks width (SDI_2)	Total number of potholes (SDI_3)	Average depth of wheel rutting (SDI)
1	-	-	Total number of potholes 1 (<10/100m) SDI_3= SDI_2 + 15 = 0 +15 = **15**	-
2	Total area of cracks <u>146,56 m^2</u> x100 / 1400 m^2 =10,46 % = 10-30% SDI_1 = **20**	Average cracks width 4 mm (>3mm) SDI_2 = SDI_1 x 2 =20 x 2 = **40**	Total number of potholes 1 (<10/100m) SDI_3= SDI_2 + 15 = 40 +15 = **55**	Depth of wheel rutting 6 cm SDI = SDI_3 +5x = 55 + 5*4 = 55 + 20 = **75**
3	Total area of cracks <u>411,50 m^2</u> x100 / 1400 m^2 =29,39 % = 10-30% SDI_1 = **20**	Average cracks width 4 mm (>3mm) SDI_2 = SDI_1 x 2 =20 x 2 = **40**	-	Depth of wheel rutting 6 cm 5cm SDI = SDI_3 +5x = 0 + 5*4 = 0 + 20 = **20**
4	Total area of cracks <u>49,71 m^2</u> x100 / 1400 m^2 =3,55 % = < 10% SDI_1 = **5**	Average cracks width 4 mm (>3mm) SDI_2 = SDI_1 x 2 =5 x 2 = **10**	Total number of potholes 1 (<10/100m) SDI_3= SDI_2 + 15 = 10 +15 = **25**	-
5	Total area of cracks <u>201,60 m^2</u> x100 / 1400 m^2 =14,4 % = 10 – 30% SDI_1 = **20**	Average cracks width 5 mm (>3mm) SDI_2 = SDI_1 x 2 =20 x 2 = **40**	Total number of potholes 1 (<10/100m) SDI_3= SDI_2 + 15 = 40 +15 = **55**	-

Based on the calculation of road surface conditions, it can be concluded that the Gresik, Surabaya road in Segment 1 has a good road condition level, segment 2 has a moderate road condition level, segment 3 has a good road condition level, segment 4 has a good road condition level, and segment 5 has a moderate road condition level. Based on the results of direct observation, data is obtained as material for calculating the Surface Distress Index (SDI) method as follows:

a. Calculating the Area of Cracks (Total Area Of Cracks)
   In calculating the crack area (SDI1), namely looking for the percentage of cracks in each segment by dividing the total crack area obtained from segment 1 by the segment area (14 m x 100 m), then multiplying by 100% so as to get the percentage of the crack area of each segment, for example in segment 2, as follows:
   Using a crack area of 146,56 m2 in segment 2, the percentage of crack area in segment 2 is calculated as follows:
   SDI1 = Total Cracked Area x 100% = 146.56 x 100 = 10.46%
   Area 1 Segment 1400
   So that the SDI1 value is 20.
b. Calculating the Average Crack Width
   Calculating the average width (SDI2): if a crack has a crack width < 1 mm or (1-3) mm, the SDI2 value is the same as the SDI1 value, but if the crack width in a segment has a size> 3 mm, the SDI1 calculation result is multiplied by 2.
   Segment 2 has an average crack width of 4 mm, so the average crack width is > 3 mm.
   So the SDI2 value is SDI1 x 2 = 40.
c. Calculating the Total Number Of Potholes
   Calculate the number of potholes faithfully every 100 meters, or every 1 segment. In segment 2, there is 1 hole, so it falls into the category of the number of holes per 100 m. Then the formula obtained is
   So, SDI3 = SDI2 + 15 = 40 + 15 = 55.
   The next segment will be shown in Appendix 3.
d. Calculating Ruts (Rutting)
   Calculating ruts is the same as calculating the depth of ruts in each segment. In segment 2, the depth of the ruts is obtained at 6 cm, or according to the depth formula, > 3 cm, so that the variable value x = 4 is obtained and the SDI value obtained in segment 2 is
   SDI = SDI3 + 5 x
   = 55 + 5 x 4
   = 75
   In relation to SDI with road classification, the results of the SDI calculation in segment 2 are in moderate condition.

The results of calculations using the Surface Distress Index (SDI) method were obtained for each segment. The results of the quality classification of each segment can be seen in the following figure:

Figure 4. SDI Value Graph of the entire Segment

Based on the graph of the SDI value of the entire segment, it can be seen that the level of damage that gets a medium SDI value is in segment 2, where the segment gets an SDI value of 75, while the lowest value is in segments 19 to 22, which gets an SDI value of 0, where in the segment there is no damage and the pavement in the segment is in good condition. The average SDI value on the Gresik-Surabaya road section, Km 4 + 900 to Km 7 + 700, is a road in good condition that only requires repair and maintenance on several segments.

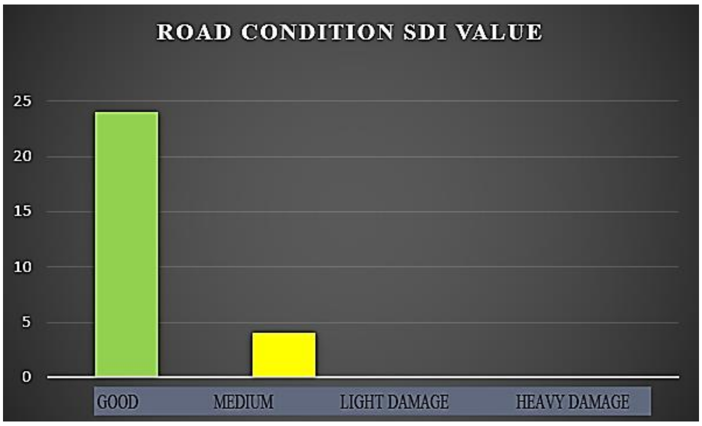

Figure 5. Graph of Road Condition Value

Based on Figure 6, The Road Condition Value Graph shows that of the 28 segments on the Gresik-Surabaya road section, 24 segments get a good value and 4 segments get a moderate road condition value, namely in segments 2, 3, 5, and 6, where at that location there is quite a lot of crack damage.

The road damage handling method used on road damage on Gresik Road in Surabaya City refers to Bina Marga 2011. An example of handling that can be taken is damage to segment 2 because the road conditions get a medium SDI value. The following is the road handling method for segment 2.

1. Damage Type: Crack
   Type of Handling (P4):
   a. Mobilize equipment, workers, and materials to the repair site.
   b. Install safety signs at the repair site.
   c. Prepare equipment.
   d. Mark the spot to be repaired and clean the spot.
   e. Fill cracks with asphalt emulsion using asphalt sprayer or asphalt kettle.
   f. Spread coarse sand on the repaired area with a thickness of 10 mm.
   g. The coarse sand is compacted using a baby roller until the surface is flat (minimum 3 passes).
   h. Clean the work area from the remaining materials and remove safety signs, then demobilize.
2. Type of Damage: Potholes
   Type of Handling (P5):
   a. Mobilize equipment, workers, and materials to the repair site.
   b. Install safety signs at the repair site.
   c. Prepare equipment.
   d. Mark the area to be repaired and clean the area.
   e. Excavate the road foundation material until it reaches the hard layer (typically 150 - 200 mm pavement depth).
   f. Compact the excavation base using a vibrating hammer.
   g. Spread Class A aggregate with a thickness of max. 100 mm in OMC state.
   h. Then each layer of grade A aggregate is compacted to 40 mm below the surface with vibrating hammer.
   i. Apply prime coat using Asphalt sprayer.
   j. Overlay the hot mix asphalt, then compact it using a baby roller with minimum passes. If necessary, asphalt material can be added and then check the flatness of the surface.
   k. Clean the work area from the remaining materials and remove the safety signs, then demobilize.
3. Type of Damage: Whell ruts
   Type of Handling (P6):
   a. Mobilize equipment, workers, and materials to the repair site.
   b. Install safety signs at the repair site.
   c. Prepare equipment.
   d. Mark the area to be repaired and clean the area.
   e. Apply tack coat using an asphalt sprayer.
   f. Mix aggregates for cold mixes with a concrete mixer, the maximum capacity of the mixer is approximately 0.1 m3. For cold mixes add aggregate (0.1 m3) before asphalt.
   g. Add the asphalt material and mix for 4 minutes. Prepare enough cold/hot asphalt mix to complete the job.
   h. Sprinkle the cold asphalt on the treated surface (min. 10 mm thickness).
   i. Compact with baby roller (min. 5 passes).

j. Clean the field and check the flatness with the existing surface.
k. Lift the equipment using a flat bed truck equipped with a crane.
l. Lift back with safety signs.
m. Demobilization.

CONCLUSIONS

Based on the results of calculations and analysis carried out on the surface of the Gresik road in Surabaya, East Java, it can be concluded as follows:

1. On the Gresik Surabaya road section, East Java, from segments 11 to 18 and continuing on segments 26 to 28, the damage that is enough to get a large SDI value is wheel marks. While in segments 2, 3, 5, and 6, the damage that gets the largest SDI value with moderate damage classification is cracking. The dominating road damage on the Gresik-Surabaya road from Km 4+900 to Km 7+700, or from segment 1 to segment 28, is ruts and cracks. But for a little hole damage found in the road condition survey. Handling refers to Bina Marga 2011 regarding maintenance of road surface damage, so the types of repairs that need to be done on the Gresik road, Surabaya, East Java, are P4 (crack filling), P5 (patching holes), and P6 (leveling).
2. In the measurement of pavement on the surface of Gresik Road, Surabaya, along 2800 meters, which is divided into 28 segments, damage is obtained based on the parameters of the Surface Distress Index (SDI) method, namely crack area, crack width, holes, and ruts. With the SDI value obtained as follows:
    a. A moderate SDI value is obtained in segment 2 with a SDI value of 75, Segment 3 with a SDI value of 60, segment 5 with a SDI value of 55, and segment 6 with a SDI value of 55.
    b. Good SDI value is obtained in segment 1 with SDI value 15, segment 4 with SDI value 25, segment 7 and 8 with SDI value 25, segment 9 with SDI value 10, segment 10 with SDI value 25, segment 11 to 18 with SDI value 20, segment 19 to 22 with SDI value 0, segment 23 and 24 with SDI value 15, segment 25 with SDI value 10, and segment 26 to 28 with SDI value 35.

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