

## DETERMINING ROAD HANDLING ACCORDING TO THE LEVEL OF DAMAGE USING SURFACE DISTRESS INDEX (SDI) METHOD (Case study on Jl. Merdeka 1 Sukabumi City)

**Paikun Paikun, Elis Suminar, Aldi Irawan, Saiful Bahri**

Civil Engineering Departement, Nusa Putra University, INDONESIA

E-mail: [paikun@nusaputra.ac.id](mailto:paikun@nusaputra.ac.id), [elis.suminar\\_ts17@nusaputra.ac.id](mailto:elis.suminar_ts17@nusaputra.ac.id)

### ABSTRACT

Roads that have been functioned are in good condition, slightly damaged, moderately damaged, and heavily damaged, therefore road maintenance is needed. Road maintenance uses costs, and the available costs are often insufficient to carry out road repairs as a whole, so it is necessary to determine the priority scale of road repairs. The Surface Distress Index (SDI) method is a method used by the DGH to determine the level of road damage, furthermore as a basis for determining the priority scale for road repairs. Along 2.25 km of Jalan Merdeka 1, Sukabumi City, it is the sampling location for the study to determine the condition of road damage. Each investigation point is determined to be 200 m long, starting from the initial STA 0 + 000 - 0 + 200 to the last STA 2 + 200 - 2 + 250. The results showed that the road conditions consisted of moderately damaged, lightly damaged to heavily damaged, so it needed maintenance at STA 0 + 000 - 0 + 400, it needed rehabilitation at STA 0 + 400 - 1 + 800 and STA 2 + 200 - 2 + 250, as well as need reconstruction at STA 1 + 800 - STA 2 + 200. The results of this study can be used as a basis for determining road handling by policymakers.

**Keywords:** road damage; Surface Distress Index (SDI); road handling

Received:	Revised:	Accepted:	Available online:
2021-02-13	2021-03-06	2021-03-29	2021-04-21

### INTRODUCTION

The road is a means of transportation infrastructure that includes all parts of the road including complementary buildings (RI Law Number 38 of 2004). Land transportation is very important for society in smoothing the economy and culture between regions in Indonesia (Junaidi et al. 2020 and Muhammad et al. 2020). Good road conditions will make it easier for the community to carry out other social activities (Jatmika et al. 2018 and Kadarisman et al. 2016). To find out information on road availability that connects activity centers in regencies/cities, to make it easier for the community to travel, ensure road users drive comfortably and safely, ensure that vehicle trips can be carried out according to planned speed, a Road Database is needed (MAP 2020).

Sukabumi City is located 120 km south of Jakarta and 96 km west of Bandung, is in the northeast of the Sukabumi Regency area, and administratively the entire city area borders the Sukabumi Regency area. Sukabumi City is culturally part of the West Priangan region (Pangestu 2020). The Transportation Agency of Sukabumi City has a road database, namely, city, arterial, secondary and local roads, which are recorded as many as 149 roads. However, with the construction of additional roads and road widening, there have been changes in road data in Sukabumi City. Jalan Merdeka 1 Sukabumi City is a city road with a length of 2.25 km, serving 2-way traffic flow, repeated by vehicles with high traffic volume. So that it is necessary to investigate and collect data on-road vehicles, road damage, and handling.

The road database owned by the transportation agency has not been detailed in conveying road information, such as data on road damage and determining road handling. To find out the condition of road sections and road damage, a survey is needed and requires road data IRMS / Integrated Road Management System (S. Lim 2009). Roads that are traversed repeatedly with high traffic volumes will affect road construction conditions, and result in a decrease in road quality, thus impacting safety, comfort, and smoothness in traffic (Aptarila et al. 2020). Therefore, this research is important to do to determine the level of road damage, handling of road damage on Jl. Merdeka 1 Sukabumi city.

By using PCI and rigid pavement, the road will increasingly show its true strength. The strength of the road and surface coating is determined by how much the subgrade is strengthened so that the road is very durable. A long life path will have little effect on maintenance. Minimal maintenance will make the path of high quality (Eri S.H, Rulhendri, 2013); (Dede S, 2015); (S Syaiful, L. Lasmana, 2020).

#### **Research purposes**

- 1) To determine the level of road damage using the Surface Distress Index (SDI) method
- 2) To determine road conditions that require maintenance, rehabilitation, and reconstruction handling.

The results of this research are expected to be utilized by policymakers and road managers in carrying out appropriate road handling by road damage conditions and road handling promptly.

The systematic writing of this paper will then discuss the literature review to determine the theoretical basis, discuss research methodology to explain research steps, discuss research results to convey arguments in achieving results, and convey conclusions of research results.

#### **Definition of the Way**

According to the Law of the Republic of Indonesia No. 38 of 2004, it is stated that the road is a means of transportation infrastructure that includes all parts of the road including complementary buildings intended for traffic, which are above ground level, below ground level, and/or water, and above water level, except railroad roads, lorries, and cable roads.

#### **Road Damage**

Types of pavement damage include: 1) Deformation. Deformation is a change in the road surface from its original profile after construction, consisting of wavy grooves, subsidence, shovels, swelling, and falling; 2) Cracked. The crack occurs due to tensile strain on the asphalt surface that exceeds the maximum tensile strain, consisting of longitudinal, transverse, diagonal, reflective, block, crocodile skin, and crescent shape; 3) Damage to surface texture, which consists of loose grains, obesity, slippery aggregates, peeling, and stripping; 4) Damage to holes, which consist of road patches and crossings; 5) Damage along the pavement includes cracked/broken edges and descending shoulders (Bina Marga 1995 and Yuono, Sungkono 2019).

#### **Causes of Road Damage**

The factors that cause damage to the pavement include: 1) Excessive traffic load, unstable subgrade conditions; 2) The condition of the foundation soil is not good; 3) Material from the pavement structure and poor processing; 4) Decrease due to the construction of utilities under the pavement layer; 5) Poor drainage; 6) Too much bitumen in the mixture; 7) Fatigue from the pavement, compaction, or shearing in all foundation layers (Priana 2018 and Liawan 2019)

#### **Types of Road Damage**

The types of road damage consist of; 1) Crack, which is a symptom of damage/breaking of the pavement surface so that water on the pavement surface will enter the lower layer and this is one of the factors that cause severe damage; 2) Hole (Potholes), namely damage in the form of a bowl that can hold water. This damage occurs near cracks or due to poor drainage; 3) Rutting, which is damage to the wheel tracks parallel to the axles and in the form of grooves caused by vehicle loads, causing ruts of the vehicle (Ramli et al. 2018 and Rachman 2020).

### Basic theory

The Surface Distress Index (SDI) method is a road performance scale obtained from visual observations of road damage that occurs in the field. The SDI value used as an element in calculating consists of 4 elements (Yahya et al. 2019), namely:

- 1) Assessment of the percentage of crack area in road damage uses the provisions as shown in Table 1 (Strya et al, 2019).

**Table 1.** Assessment of the percentage of crack area

N	Percentage of Damage	SDI Value
1	0%	0
2	< 10%	5
3	10 - 30%	20
4	>30%	40

- 2) The assessment of the average crack width uses the provisions as shown in Table 2 (Irianto. And R. Rochmawati 2020).

**Table 2.** Crack width assessment

N	Crack Width	SDI Value
1	None	SDI x 1
2	Fine (<1 mm)	SDI x 1
3	Medium (1-3 mm)	SDI x 1
4	Wide (>3 mm)	SDI x 2

- 3) Assessment of the number of holes as shown in Table 3 (Melyar 2021).

**Table 3.** Assessment of the number of holes

N	Number of Holes	SDI Value
1	None	SDI + 0
2	2 / 200 m	SDI + 15
3	3 -10 / 200 m	SDI + 75
4	>10 / 200 m	SDI + 225

- 4) 4) Assessment of vehicle ruts as shown in Table 4 (Nusmanti and Prawinata 2021).

**Table 4.** Ruts hole assessment

N	Hole Due to Vehicle Wheels	SDI Value
1	None	SDI + 0
2	< 1 cm	SDI + 2,5
3	1 – 3 cm	SDI + 10
4	> 3 cm	SDI + 20

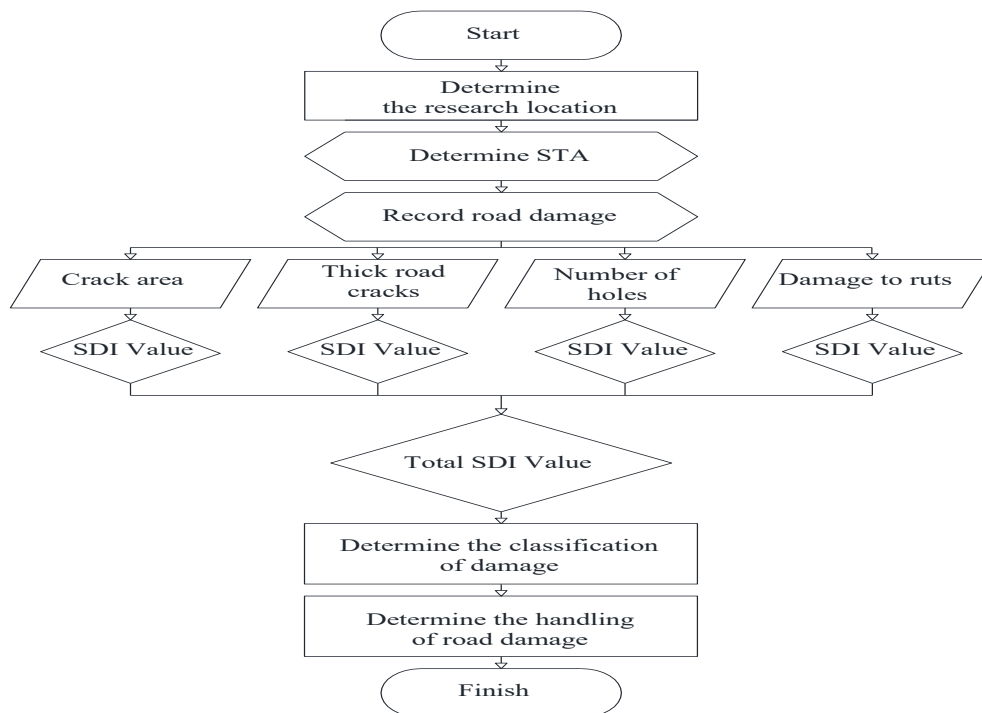
Based on the number of 4 assessment elements, the road condition can be categorized as good if the SDI value is <50, moderate condition if the SDI value is 50-100, the condition is lightly damaged if the SDI value is 100-150, and the condition is heavily damaged if the SDI value is >150 (Baihaqi et al 2018) as described in Table 5.

**Table 5.** Damage category

Total SDI Value	Damage category
<50	Good
50 - 100	Moderate
100 - 150	Light Damage
>150	Heavy Damage

**RESEARCH METHODS**

This research uses quantitative methods. The quantitative data uses primary data from surveys and direct investigations on Jl. Merdeka 1 Sukabumi city along 2,250 m with an average road width of 7.66 m. The data collection technique uses the Street Map method, which is to determine the center points of the investigation consisting of points 1 - 12, starting from STA 0 + 00 to STA 2 + 250. Each STA is determined to have a road length of 200 m, except for the last STA the road length is only 50 m. Each STA identifies the type of road damage which is then analyzed using the Surface Distress Index (SDI) method to determine the classification of damage and how to handle it. The stages of this research are briefly described in Figure 1 below.



**Figure 1.** Research flow

## RESULTS AND DISCUSSION

### Determining the Research Location

The research object is the road section on Jl. Merdeka 1 Sukabumi city because this road is one of the city roads that serve 2-way traffic flow, has a length of 2,250 m and a width of 7.66 m. This road is a land transportation route that is very important for the community in accelerating the economy, tourism, culture between regions in Indonesia, access from various regions to terminals, markets, and other shopping centers, as well as the Ciletuh Geopark. So that this location becomes an important location for investigations to be of benefit to policymakers and road managers. In general, the research locations are illustrated in Figure 2 below.

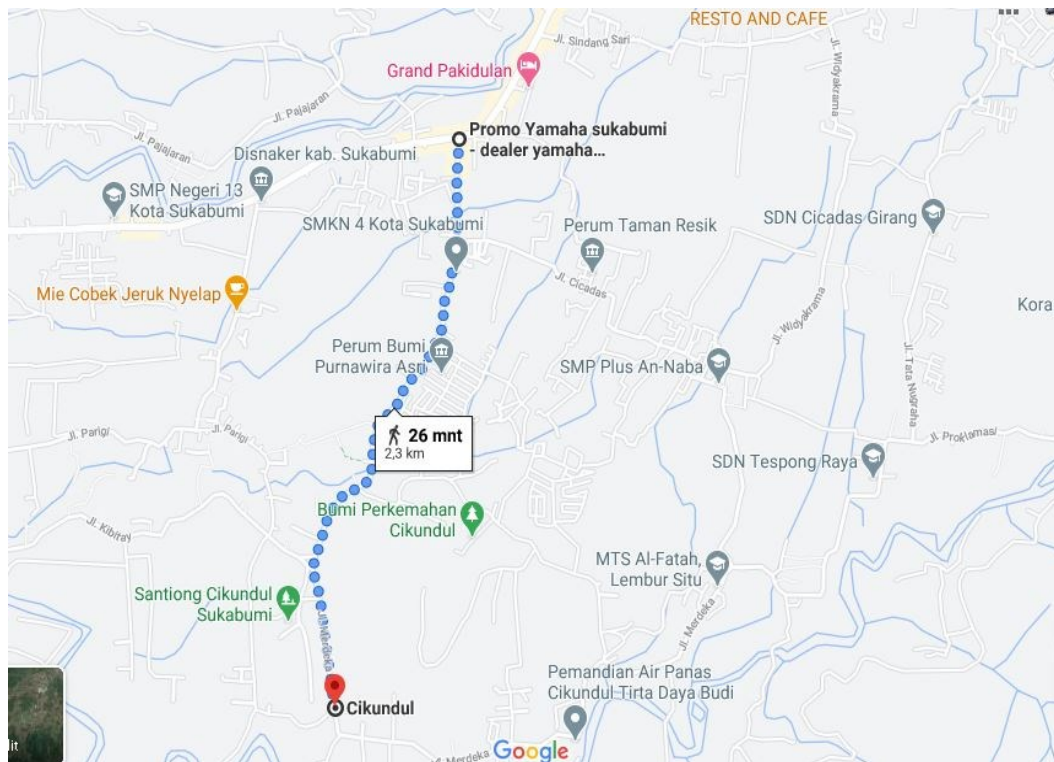


Figure 2. Map of the location of Jl. Merdeka 1 Sukabumi City

The basis for determining the location of the object of research on Jl. Merdeka 1 Sukabumi City, because this road is accessed from the area to the city, access to shopping places, access to government offices, and there are also road damage. Description of road conditions as shown in Figure 3.

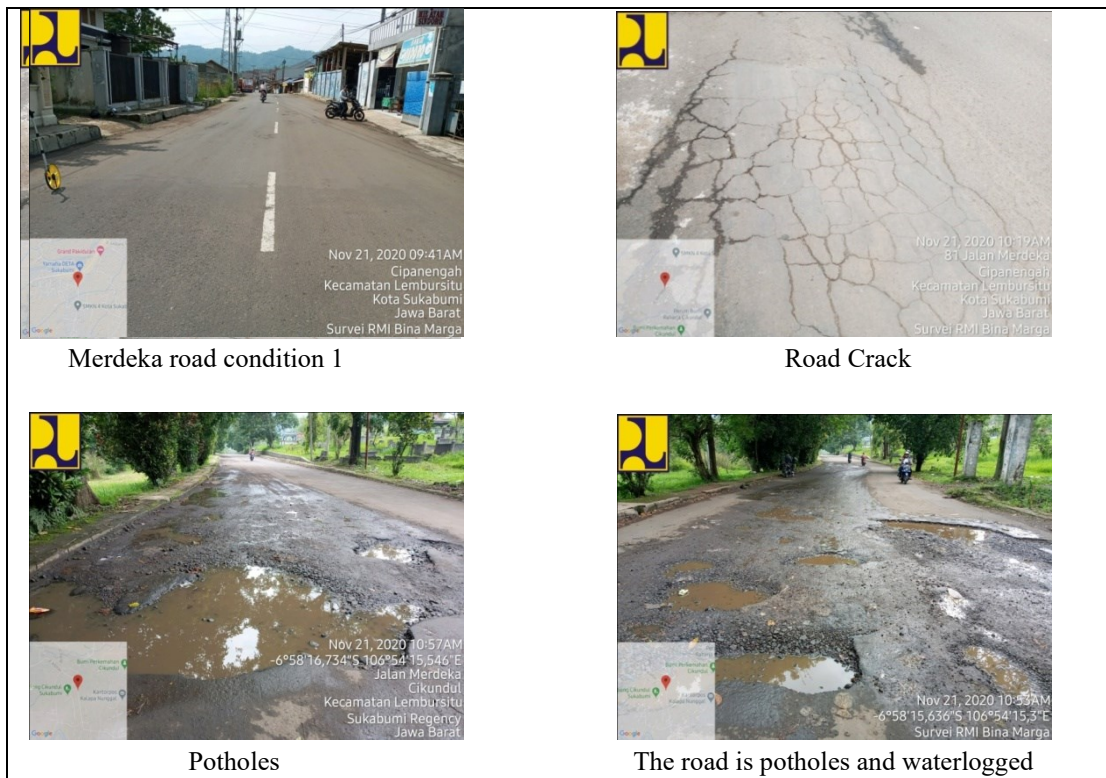


Figure 3. Condition of Jl. Merdeka 1 Sukabumi city

**Road Damage Data Collection**

Data collection on road conditions in this study is a must. The collection of data on road conditions includes the number of cracks, the area of the cracks, the thickness of the cracks, the number of holes, and the damage to vehicle ruts. The road damage data collection uses the StreetMap method, which is to divide the segment by 200 m in length per segment, and the width using the average width because the width of the road for each segment is different. Stationing position (STA) 0 + 000 starting from the intersection of Jalan Pelabuhan 2 and the final STA position on Jl. Merdeka 2. Segment division scheme as illustrated in Figure 4 below.

Segment length	200 m	200 m	200 m	200 m	200 m	200 m	200 m	200 m	200 m	200 m	200 m	50 m
STA	0+00	0+200	0+400	0+600	0+800	1+000	1+200	1+400	1+600	1+800	2+000	2+250
	0	1	2	3	4	5	6	7	8	9	10	11
												12

Figure 4. The data on road damage using the StreetMap method

Based on the results of surveys and investigations as a schematic in Figure 4, it is known that road conditions consist of cracks, holes, and damage by vehicle wheels. The road damage then

becomes quantitative data consisting of the number of cracks, crack area, crack thickness, the number of holes, and the number of holes caused by vehicle wheels. This quantitative data then analyzed using the Surface Distress Index (SDI) method.

### Data Analysis with Surface Distress Index (SDI) Method

The first step in analyzing data using the Surface Distress Index (SDI) method is to determine the road area for each segment. It has been determined that the road length per segment is 200 m, except for the last segment which is 50 m long. The road width for each segment is different, so to determine the area of each segment, the average road width is determined. The calculation results show that the average road width is 7.66 m, therefore calculating the road area for each segment as shown in STA 0 + 00 to 0 + 200 as follows:

The road segment for STA 0 + 000 s / d 0 + 200

- The area of the road = Handled length x Average road width  
= 200 x 7,66 m

The results of the analysis show that the road area of the STA 0 + 000 to 0 + 200 segment is 1,532 m<sup>2</sup>.

After knowing the width of the road segment for each segment, the Surface Distress Index (SDI) method analysis is carried out, including the percentage of road cracks, crack thickness, number of holes, and the number of holes ex. wheels. The basis for making decisions on the results of the analysis is determined as follows:

- Thickness of crack = 3mm (Medium = 1)
- Number of holes = 5 (medium = 75)
- Wheel rut = 0 (NONE = 0)

To find out the SDI value for each segment, it is necessary to determine the symbol for each type of damage, therefore it is determined that crack area = A, crack thickness = B, number of holes = C, and number damaged by wheels = D. Analysis to determine the SDI value through the following stages:

#### 1) SDI analysis of the percentage of road cracks (A)

It is known that the STA 0 + 000 to 0 + 200 there is a road crack with a length of 52 m, a width of 7.4 m, then the SDI A value can be calculated as follows:

$$\begin{aligned} \text{Crack area} &= \text{crack length} \times \text{crack width} \\ &= 52 \times 7,4 \text{ m} \\ &= 384,8 \text{ m}^2 \\ A &= \frac{\text{Crack Area}}{\text{Road Area}} \times 100\% \\ &= \frac{384,8 \text{ m}^2}{1532 \text{ m}^2} \times 100\% = 25,11 \% \\ \text{So that the SDI value A is} &= \mathbf{20} \end{aligned}$$

#### 2) SDI Analysis of Crack Thickness (B)

To get the SDI B value (crack thickness), it is necessary to first know the SDI A value (crack area), and the crack thickness (mm). Based on the survey results, it is known that the width of the cracks in STA 0 + 000 to 0 + 200 is 1 mm, and based on the analysis the value of SDI A is 20 so that the SDI B value can be determined based on the following analysis:

$$\begin{aligned}
 B &= \text{SDI A} \times \text{Category Crack Thickness} \\
 &= 20 \times 1 = 20 \\
 \text{So that the SDI B value is} &= \mathbf{20}
 \end{aligned}$$

2) SDI Analysis Number of Damage Holes (C)

To get the SDI C value, it is necessary to first know the SDI B value, and the value of the damage hole category. The analysis results show that the SDI B value is 20, and based on the survey data it is known that the number of holes in STA 0 + 000 to 0 + 200 is 5 holes, so the category value of the damage holes is 75. Based on these data, the SDI value C (number of holes in damage) can be analyzed as follows:

$$\begin{aligned}
 C &= \text{SDI B value} + \text{Damage Hole category value} \\
 &= 20 + 75 = 95 \\
 \text{So that the SDI C value is} &= \mathbf{95}
 \end{aligned}$$

3) SDI Analysis of Used Wheel Holes (D)

To get the SDI D value, it is necessary to first know the SDI C value and the average value of the depth of the vehicle ruts. It is known that the SDI C value based on the results of the analysis is 95, and the mean value of the depth of the used vehicle pits is 0, so the SDI D value can be analyzed as follows:

$$\begin{aligned}
 D &= \text{SDI value C} + \text{Average value of rut depth} \\
 &= 95 + 0 = 95 \\
 \text{So that the value of SDI D value is} &= \mathbf{95}
 \end{aligned}$$

Decision making for the category of damage based on the SDI value is determined that the total SDI value is  $<50$  = good, the total SDI value is 50-100 = moderate, the total SDI value is 100-150 = lightly damaged, the total SDI value  $> 150$  = damaged weight. Based on the analysis steps, it is known that at STA 0 + 000 to 0 + 200 the total value of SDI = 95, it is in the moderate category, therefore the handling is needing maintenance.

Based on the SDI analysis stages as exemplified in STA 0 + 000 s / d 0 + 200, all segments in the study were analyzed in the same way. The results of the road damage analysis on Jl. Merdeka 1 Sukabumi city along 2,250 m, as a whole is summarized in Table 6 below.

**Table 6.** SDI value for Jl. Merdeka 1

STA	Crack Area (SDI Value)	Thickness Area (SDI Value)	Number of Holes (SDI Value)	Damage Used Wheels (SDI Value)	Total (SDI Value)	Damage Category
0+000 - 0+200	25,11 % (20)	3mm (x1)	5 (75)	None (0)	95	Moderate
0+200 - 0+400	37,12 % (40)	2mm (x1)	2 (55)	None (0)	95	Moderate
0+400 - 0+600	20,30 % (40)	5mm (x1)	6(75)	None (0)	115	Slightly Damaged
0+600 - 0+800	27,82 % (40)	5mm (x1)	7 (75)	None (0)	115	Slightly Damaged
0+800 - 1+000	23,18% (40)	5mm (x1)	9 (75)	None (0)	115	Slightly Damaged
1+000 - 1+200	40,14 % (40)	1mm (x1)	8 (75)	None (0)	115	Slightly Damaged



1+200 - 1+400	17,46 % (40)	6mm (x1)	9 (75)	None (0)	115	Slightly Damaged
1+400 - 1+600	47,85 % (40)	3mm (x1)	6 (75)	None (0)	115	Slightly Damaged
1+600 - 1+800	49,54 % (40)	3mm (x1)	6 (75)	None (0)	115	Slightly Damaged
1+800 - 2+000	3,89 % (5)	3mm (x1)	16 (225)	None (0)	230	Heavily Damaged
2+000 - 2+200	56,49 % (40)	2mm (x1)	16 (225)	None (0)	265	Heavily Damaged
2+200 - 2+250	32,64 % (40)	1mm (x1)	4 (75)	None (0)	115	Slightly Damaged

The results of the analysis of the Surface Distress Index (SDI) method are shown in Table 6. It is known that the condition of Jl. Merdeka 1, Sukabumi city is in moderate condition, slightly damaged and heavily damaged in the respective STA segment. Therefore, it can be seen the appropriate type of treatment for each segment as suggested in Table 7 below.

**Table 7.** Handling road damage per segment

STA Initial	STA End	Damage Category	Type of treatment
0+000	0+200	Moderate	Maintenance
0+200	0+400	Moderate	Maintenance
0+400	0+600	Slightly Damaged	Road Rehabilitation
0+600	0+800	Slightly Damaged	Road Rehabilitation
0+800	1+000	Slightly Damaged	Road Rehabilitation
1+000	1+200	Slightly Damaged	Road Rehabilitation
1+200	1+400	Slightly Damaged	Road Rehabilitation
1+400	1+600	Slightly Damaged	Road Rehabilitation
1+600	1+800	Slightly Damaged	Road Rehabilitation
1+800	2+000	Heavily Damaged	Road Reconstruction
2+000	2+200	Heavily Damaged	Road Reconstruction
2+200	2+225	Slightly Damaged	Road Rehabilitation

Table 7 explains the road damage category on Jl. Merdeka 1 Sukabumi City, as well as suggestions for proper road damage handling based on the SDI method. To visually understand the location points of the requiring further maintenance, rehabilitation and reconstruction should be submitted using the StreetMap method.

### Street Map Method

The StreetMap method is used as a pattern for conducting research data collection for each segment, facilitating the explanation of the interpretation of the SDI analysis results, and finding out points of road conditions that require maintenance, rehabilitation, and reconstruction. The results of the road mapping for each segment based on the results of SDI analysis are described in figure 5 below.

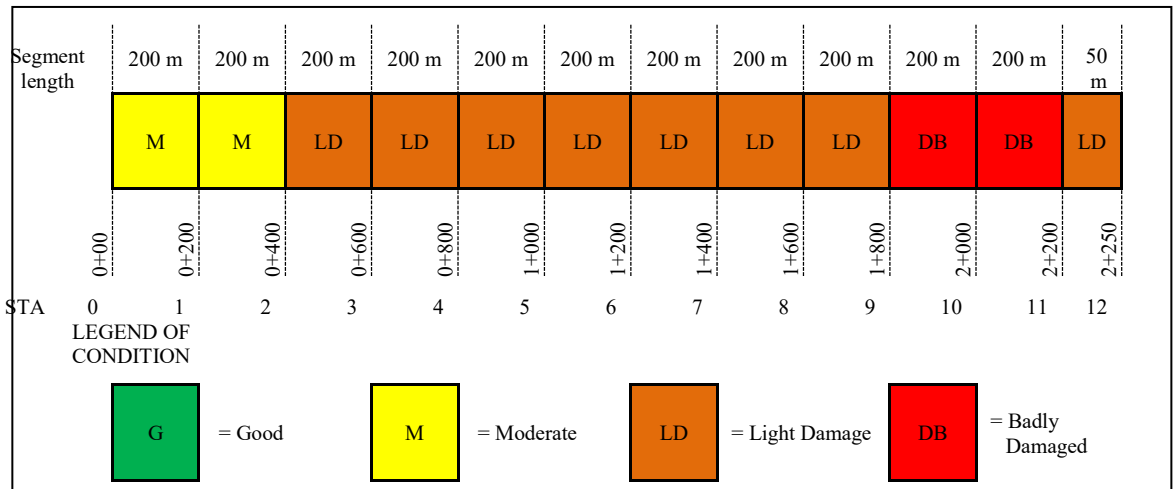


Figure 5. StreetMap method. Damage to the road on Jl. Merdeka 1

Research to determine the condition of road damage on Jl. Merdeka 1 Sukabumi city uses the Surface Distress Index (SDI) method, then visualized using the Street Map method it can be interpreted that at STA 0 + 00 - 0 + 400 along 400 m the condition is moderately damaged and requires maintenance. The conditions of STA 0 + 400 - 1 + 800 and STA 2 + 200 - 2 + 250 along 1,450 m are slightly damaged and require rehabilitation. The condition of STA 1 + 800 - 2 + 200 along 400 m was badly damaged and needed reconstruction. Based on data collection and analysis in this study, it can be used as a basis for decision-making by road policymakers and managers to carry out road handling. Furthermore, it is necessary to estimate costs to find out the amount of the budget required.

**CONCLUSION**

This research has succeeded in identifying road conditions with different road damage conditions at several stations. Condition Jl. Merdeka 1 Sukabumi City is not in a good condition. A total of 2,250 m was damaged consisting of moderate damage, minor damage, and heavy damage. The damage to Merdeka 1 road along 2,250 m based on the Surface Distress Index (SDI) method shows that at STA 0 + 00 - 0 + 400 along 400 m, the condition is moderately damaged and requires maintenance. The conditions of STA 0 + 400 - 1 + 800 and STA 2 + 200 - 2 + 250 along 1,450 m are lightly damaged and require rehabilitation. The condition of STA 1 + 800 - 2 + 200 along 400 m is severely damaged and needs reconstruction. These findings can be utilized by policymakers and road managers to carry out road handling by road damage conditions.

**ACKNOWLEDGMENT**

Praise the presence of Allah SWT for the gift we were able to complete the research. Thanks to the rector and director of LPPM Nusa Putra University who have fully supported the implementation and success of this research.

## REFERENCE

- Aptarila, G., Lubis, F., & Saleh, A. (2020). Analisis Kerusakan Jalan Metode SDI Taluk Kuantan - Batas Provinsi Sumatera Barat. *Siklus: Jurnal Teknik Sipil*, 6 (2), 195 -203. (Indonesian). <https://doi.org/10.31849/siklus.v6i2.4647>
- A. Suwandi, W. S, (2008), Evaluasi Tingkat Kerusakan Jalan Dengan Methode Pavement Condition Index (PCI) untuk Menunjang Pengambilan Keputusan. Jurusan Teknik Sipil dan Lingkungan, Fakultas Teknik, Universitas Gadjah Mada. Yogyakarta. (Indonesian).
- Baihaqi Baihaqi, Sofyan M. Saleh, Renni Anggraini. Tinjauan Kondisi Perkerasan Jalan Dengan Kombinasi Nilai International Roughness Index (Iri) Dan Surface Distress Index (SDI) Pada Jalan Takengon – Blangkejeren. *Jurnal Teknik Sipil Universitas Syiah Kuala*. (Indonesian). <http://e-repository.unsyiah.ac.id/JTS/article/view/9993>
- B. Jatmika, M. Pallah, N. Akmaliah, A. Sardi, R. F. K. Barkah and I. A. Darmawan, "The Evaluation on the Saturation Degree on Pelabuhan II Street of Sukabumi City," 2018 International Conference on Computing, Engineering, and Design (ICCED), Bangkok, Thailand, 2018, pp. 208-211, doi: 10.1109/ICCED.2018.00048
- Dede Sarwono. 2015. Kajian Pelayanan Fungsi Jalan Kota Bogor Selatan (Studi Kasus Ruas Jalan Bogor Selatan Zona B). *ASTONJADRO Jurnal Rekayasa Sipil*, 4 (2), pp.42-50. (Indonesian). <http://ejournal.uika-bogor.ac.id/index.php/ASTONJADRO/article/view/826>
- Dimas Aldi Pangestu. Modernisasi: Sukabumi Dalam Arus Perubahan Sosial Ekonomi Era Kolonial Belanda. *ISTORIA Jurnal Pendidikan dan Sejarah* Vol. 16 No. 2 (2020). (Indonesian). DOI: <https://doi.org/10.21831/istoria.v16i2.35601>. <https://journal.uny.ac.id/index.php/istoria/article/view/35601>
- Direktorat Jenderal Bina Marga, (1995), Petunjuk Pelaksanaan Pemeliharaan Jalan Kabupaten. Petunjuk Teknis No. 024/T/Bt/1995, Departemen Pekerjaan Umum, Direktorat Jenderal Bina Marga. (Indonesian).
- Direktorat Pembinaan Jalan Kota, (1990), Tata Cara Penyusunan Pemeliharaan Jalan Kota (No.018/T/BNKT/1990), Direktorat Jendral Bina Marga Departemen PU. Jakarta. (Indonesian).
- Eri Susanto Hariyadi, Rulhendri, 2013. Pengaruh Jenis Pembebanan Dalam Analisis Struktur Perkerasan Lentur Terhadap Kinerja Perkerasan. *ASTONJADRO Jurnal Rekayasa Sipil*, 2 (2), pp.49-57. (Indonesian). <http://ejournal.uika-bogor.ac.id/index.php/ASTONJADRO/article/view/798>
- Giyanto (2016), Analisa Kerusakan Jalan Dengan Metode PCI Kajian Ekonomis Dan Penanganannya. (Indonesian).
- Hendra Satrya, Muhammad Isya, Sugiarto Sugiarto. Evaluasi Kondisi Jalan Dan Penanganannya Di Kecamatan Kota Sigli Kabupaten Pidie. *Jurnal Arsip Rekayasa Sipil dan Perencanaan (Journal of Archive in Civil Engineering and Planning)*. (Indonesian). DOI: <https://doi.org/10.24815/jarsp.v2i1.13207>. <http://www.jurnal.unsyiah.ac.id/JARSP/article/view/13207>
- Husni Mubarak (2016), Analisa Tingkat Kerusakan Jalan Dengan Metode Pavement Condition Index (PCI). (Indonesian).
- Irianto. and R. Rochmawati, "STUDI PENILAIAN KONDISI KERUSAKAN JALAN DENGAN METODE NILAI INTERNATIONAL ROUGHNESS INDEX (IRI) DAN SURFACE DISTRESS INDEX (SDI) (Studi Kasus Jalan Alternatif Waena \_ Entrop)", *EJD*, vol. 13, no. 02, pp. 7-15, Sep. 2020. (Indonesian). <http://www.jurnal.umm.ac.id/index.php/dintek/article/view/557>
- Ishadi Rachman. Analisis Kerusakan Dan Rencana Anggaran Biaya Penanganan Ruas Jalan Kabupaten Kutai Kartanegara (Studi Kasus : Simpang 3 Batas Kota Tenggarong – Desa Jahab) *Jurnal Teknik Sipil dan Arsitektur* Vol. 11 No. 1 (2020). (Indonesian). <http://ejournal.untag-smd.ac.id/index.php/TEK/article/view/4981>

Jujun Junaidi, Irwan Gani, Akhmad Noor. Analisis transportasi darat terhadap pertumbuhan ekonomi di provinsi kalimantan timur. Jurnal Ekonomi & Manajemen Vol. 17 No. 2 2020. (Indonesian). <http://journal.feb.unmul.ac.id/index.php/KINERJA/article/view/7956>

Law of the Republic of Indonesia No. 38 of 2004 concerning the Way to replace the Law of the Republic of Indonesia No. 13 of 1980 concerning the Road. <http://itjen.kemenag.go.id/sirandang/peraturan/1565-38-undang-undang-nomor-38-tahun-2004-tentang-jalan>

Liawan, Distira Andy (2019) Analisis Faktor-Faktor Penyebab Kerusakan Jalan Pantura (Studi Kasus Pantura Demak – Semarang). Masters Thesis, Universitas Islam Sultan Agung. (Indonesian). <http://repository.unissula.ac.id/16474/>

Mona Melyar. PENGGUNAAN METODE SURFACE DISTRESS INDEX (SDI) DAN PAVEMENT CONDITION INDEX (PCI) UNTUK PENILAIAN KONDISI PERKERASAN JALAN (STUDI KASUS: RUAS JALAN GEUMPANG - BATAS ACEH BARAT, KABUPATEN PIDIE). (Indonesian). [https://etd.unsyiah.ac.id/index.php?p=show\\_detail&id=86900](https://etd.unsyiah.ac.id/index.php?p=show_detail&id=86900)

Muhammad Faridun Arif<sup>1</sup>, Burhamtoro<sup>2</sup>, Moch. Khamim<sup>3</sup>, Perencanaan Geometrik Jalan Nasional Tanah Merah –Jalan Nasional Suramadu Kabupaten Bangkalan, Madura. JOS -MRK Volume 1, Nomor 3, Desember 2020, Page 151-156. (Indonesian). <http://jos-mrk.polinema.ac.id/index.php/JOS-MRK/article/view/100/137>

Muh Kadarisman, Aang Gunawan, Ismiyati Ismiyati. Kebijakan Manajemen Transportasi Darat Dan Dampaknya Terhadap Perekonomian Masyarakat Di Kota Depok. Jurnal Manajemen Transportasi & Logistik Vol. 3 No. 1 2016. (Indonesian). <https://journal.itltrisakti.ac.id/index.php/jmtranslog/article/view/140>

Rafiko yahya, Mohamad Yusri bin Aman, Aji Suraji, Abdul Halim, (2019), Analisis Kerusakan Jalan Menggunakan Metode Pavement Condition Index (PCI) Dan Surface Distress Index (SDI). Malang. (Indonesian).

Rafiko Yahya, Mohamad Yusri bin Aman, Aji Suraji, Abdul Halim. Analisis Kerusakan Jalan Menggunakan Metode Pavement Condition Index (Pci) Dan Surface Distress Index (SDI). Conference on Innovation and Application of Science and Technology (CIASTECH 2019) Universitas Widyagama Malang, 02 Oktober 2019. (Indonesian). <http://publishing-widyagama.ac.id/ejournal-v2/index.php/ciastech/article/view/1127>

Sartika Nisumanti, Dimas Prawinata Prawinata. Penilaian Kondisi Jalan Menggunakan Metode International Roughness Index (IRI) Dan Surface Distress Index (SDI) Pada Ruas Jalan Akses Terminal Alang-Alang Lebar (Studi Kasus: Sp. Soekarno Hatta – Bts. Kota Palembang Km 13). UIGM Jurnal Tekno Global Vol. 9 No. 2 (2021). (Indonesian). DOI: <http://dx.doi.org/10.36982/jtg.v9i2.1302>. <http://ejournal.uigm.ac.id/index.php/TG/article/view/1302>

S. Lim, "Road Management System of National Highway ITS," 2009 Fourth International Conference on Computer Sciences and Convergence Information Technology, Seoul, 2009, pp. 624-626, doi: 10.1109/ICCIT.2009.301.

Silvester Jehadus (2019), Analisis Faktor Penyebab Kerusakan Jalan Raya Lintas Labuan Bajo – Lembor Flores, Nusa Tenggara Timur. (Indonesian).

Suhariyanto, Woro Utari. Analisis Implementasi Data Informasi Geospasial Sebagai Upaya Peningkatan Kebutuhan Perlengkapan Jalan Di Dinas Perhubungan Kabupaten Probolinggo. MAP (Jurnal Manajemen dan Administrasi Publik) Vol. 3 No. 4 DOI 10.37507/map.v3i4.291. (Indonesian). <http://jurnal.uwp.ac.id/pps/index.php/map/article/view/291>

Surya Eka Priana. Analisa Faktor Penyebab Kerusakan Jalan (Studi Kasus Ruas Jalan Lingkar Utara Kota Padang Panjang). Ruang Teknik Journal, Fakultas Teknik Universitas Muhammadiyah

Sumatra Barat Vol. 1 No. 1 (2018) (Indonesian). DOI: <https://doi.org/10.31869/rtj.v1i1.609>.  
<http://jurnal.umsb.ac.id/index.php/RANGTEKNIKJOURNAL/article/view/609>

S Syaiful, L Lasmana, 2020. A STUDY ON LEVEL OF RAILWAY ROAD DAMAGE WITH SUSTAINABLE PCI METHOD, ARPN Journal of Engineering and Applied Sciences 15 (8), 962-968. [http://www.arpnjournals.org/jeas/research\\_papers/rp\\_2020/jeas\\_0420\\_8184.pdf](http://www.arpnjournals.org/jeas/research_papers/rp_2020/jeas_0420_8184.pdf)

Yuono, T., & Dwi Sungkono, K. K. (2019). Evaluasi Kondisi Jaringan Dan Perkerasan Jalan Di Lingkungan Kelurahan Gilingan Surakarta. Jurnal Teknik Sipil Dan Arsitektur, 24(1). (Indonesian). Retrieved from <http://ejournal.utp.ac.id/index.php/JTSA/article/view/824>

Yuswardi Ramli, Muhammad Isya, Sofyan M. Saleh. Evaluasi Kondisi Perkerasan Jalan Dengan Menggunakan Metode Pavement Condition Index (Pci) (Studi Kasus Ruas Jalan Beureunuen – Batas Keumala). Jurnal Teknik Sipil Universitas Syiah Kuala Vol. 1 Speccial issue No. 3 (2018). (Indonesian).  
DOI: <https://doi.org/10.24815/jts.v1i3.10037><http://www.jurnal.unsyiah.ac.id/JTS/article/view/10037/7913>