IDENTIFICATION OF ROAD DAMAGE USING THE BINA MARGA METHOD

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Abstract

Roads are land transportation infrastructure comprising all components of the roadway, including complementary structures and facilities intended for traffic. The Cianjur–Sukabumi Connector Road is classified as a primary collector road that serves as an access route for road users traveling from Cianjur Regency to Sukabumi Regency/City. Observations were conducted along the Cianjur–Sukabumi connector road at KM 83+850 – 84+850 (1,000 m). These observations focused on identifying road damage and were carried out using a quantitative approach with calculations based on the Bina Marga method. Based on field observations, several types of pavement distress were found along the Cianjur–Sukabumi connector road, including ravelling, patches, longitudinal cracks, potholes, edge cracking, and longitudinal ruts or rutting. The average traffic volume (LHR) recorded was 6,933.4 pcu/day, placing the road in traffic class 6, with a calculated road condition value of 1.2. The analysis using the Bina Marga method produced a Priority Order (UP) value of 9.8, indicating that the segment falls under routine and preventive maintenance programs. Routine maintenance includes surface layer treatment and pavement repairs that do not aim to increase structural strength, and such activities are implemented throughout the year.

Keywords: Road Damage, Bina Marga Method, Maintenance

INTRODUCTION

The development of road infrastructure plays a crucial role in supporting community mobility, facilitating the distribution of goods and services, and promoting regional economic growth. National and provincial roads serve as the main transportation facilities whose quality must be maintained to ensure the safety and comfort of road users. However, road damage remains a common issue in various regions across Indonesia. The Ministry of Public Works and Housing (PUPR) reports that more than 40% of roads in Indonesia are in lightly to severely damaged condition, primarily due to excessive vehicle loads and insufficient periodic maintenance. This situation not only disrupts transportation flows but also increases the risk of accidents and reduces economic efficiency (Indrayana & Haratama, 2024).

Cianjur and Sukabumi Regencies are two regions in West Java with high levels of mobility, both for economic activities, tourism, and goods transportation. The Cianjur–Sukabumi connecting route is one of the road segments with relatively high traffic intensity, as it serves as an alternative access to tourist destinations in Sukabumi and a distribution route for agricultural commodities from Cianjur. According to the West Java PUPR Office, the average daily traffic (LHR) volume on the Cianjur–Sukabumi route exceeds 12,000 vehicles per day, with heavy vehicles accounting for 18–22% of the total. The high frequency of heavy vehicles accelerates deformation and damage to the pavement layers.

The road segment at KM 83+850 – 84+850 is among the sections reported to have experienced recurring damage in recent years. The identified damages include alligator cracking, potholes, and localized settlement, all of which can reduce driving comfort. This condition is worsened by the high rainfall in the Cianjur and Sukabumi areas, which averages 2,500–3,000 mm per year, causing water to infiltrate the pavement structure and weaken the subgrade support. Untreated road damage can significantly impact traffic safety. Data from the Cianjur Resort Police indicate that more than 15% of traffic accidents in 2023 were related to substandard road conditions, such as potholes, uneven surfaces, or slippery roads due to standing water. Motorcyclists are particularly vulnerable to accidents along damaged road sections. In addition, travel time on the Cianjur–Sukabumi route has reportedly increased by up to 20% during the rainy season because drivers slow down when passing through damaged road portions.

Another issue arising from road damage is decreased economic efficiency. Damaged roads can increase vehicle operating costs (VOC) by 10–30%, including higher fuel consumption, accelerated tire wear, and damage to vehicle suspension components. This condition has a direct impact on logistics costs for businesses operating in the Cianjur and Sukabumi regions. Research from the Transportation Research and Development Agency shows that road damage reduces the smooth flow of goods and lowers distribution productivity.

In the context of road planning and maintenance, a valid and standardized method of damage evaluation is essential. One widely used method in Indonesia is the Bina Marga Method, which classifies road damage based on type, severity, and extent. This method provides clear guidelines for determining the appropriate maintenance actions, whether routine maintenance, periodic maintenance, rehabilitation, or reconstruction. By applying the Bina Marga Method, road condition assessments can be conducted objectively and assist planners in determining priority scales for repair. Identifying road damage on the KM 83+850 – 84+850 segment using the Bina Marga Method is crucial to determining the dominant types of damage, their severity, and the estimated treatment required. The findings can serve as a foundation for developing more effective and efficient road maintenance plans. With proper maintenance, pavement service life can be extended, repair costs minimized, and road user safety improved (Ula et al., 2024).

Therefore, this study aims to analyze road damage conditions on the Cianjur–Sukabumi connecting route at KM 83+850 – 84+850 using the Bina Marga Method. Through comprehensive analysis, this research is expected to contribute to regional government efforts in formulating sustainable road maintenance policies, while supporting community mobility and economic growth in the Cianjur and Sukabumi areas.

REVIEW OF LITERATURE

Road Damage

Road damage refers to the decline in the functional condition of pavement due to vehicle loads, environmental factors, and construction-related issues. According to (Dewayani & Rachmi, 2025), common types of damage found in asphalt pavement include cracking, potholes, rutting, depression, and ravelling. Such damage may result from external factors such as vehicle loads exceeding the design capacity (overloading), standing water, and unstable subgrade conditions. Damage may also arise from drainage failures, which allow water to infiltrate the pavement layers and reduce their structural strength.

Factors Causing Road Damage

According to (Faritzie et al., 2022), several main factors contributing to road damage include:

1. Excessive traffic loads, particularly heavy vehicles that exceed the maximum allowable axle load.
2. Climatic influences, such as high temperatures that accelerate asphalt aging and high rainfall that leads to water penetration.
3. Construction quality, including non-compliance with material specifications and inadequate compaction.
4. Drainage conditions, where poor drainage performance can accelerate pavement deterioration.
5. Pavement service life, in which pavements that have exceeded their design life (10–20 years) begin to experience functional degradation.

Road Damage Identification Method

Road damage identification is conducted to assess pavement conditions and determine the necessary maintenance actions. According to (Muizzi, 2023; Prasetyo et al., 2025; Susono et al., 2023; Yeni et al., 2023), identification can be carried out through visual inspection, geometric measurements, and damage index calculations. Visual inspection allows the collection of data regarding the types of damage, severity levels, and extent of the affected areas. Meanwhile, geometric measurements can be used to analyze surface deformation, such as rutting and depressions. The results of the identification process form the basis for determining pavement condition values, such as the Pavement Condition Index (PCI) and assessments based on the Bina Marga Rating System.

RESEARCH METHOD

This study employs a descriptive quantitative approach aimed at identifying and analyzing the condition of road damage along the Cianjur–Sukabumi connector at KM 83+850 – 84+850. The data used consist of primary and secondary data. Primary data were obtained through field surveys using visual inspection methods to record the types of damage, severity levels (low, medium, high), and the extent or length of damage in accordance with the Bina Marga Road Condition Survey Manual. In addition, measurements of damage dimensions were conducted using measuring tools such as tape measures, steel rulers, documentation cameras, and pavement condition recording forms. Secondary data were obtained from relevant agencies, such as the Public Works and Spatial Planning Office (PUPR), including road maps, average daily traffic volume (LHR), and historical maintenance records of the road segment.

Data analysis was carried out based on the Pavement Condition Assessment Method of Bina Marga, which includes identifying types of damage (cracking, potholes, rutting, ravelling, and others), determining severity levels, and calculating damage scores according to the Bina Marga technical guidelines (2017). Each type of damage is assigned a specific weight value, followed by the calculation of the Road Condition Index (Nilai Kondisi Jalan/NKJ) to determine the pavement condition classification (Mukhoyyaroh & Suharso, 2025). The resulting damage score analysis is then used to determine appropriate maintenance recommendations, such as routine maintenance, periodic maintenance, rehabilitation, or reconstruction.

RESULTS AND DISCUSSION

This observation was conducted on the road section connecting Cianjur Regency to Sukabumi Regency/City, located at KM 83+850 – 84+850 (1,000 meters). This segment serves as a primary collector road that provides access for road users traveling from Cianjur Regency toward Sukabumi Regency/City. The following illustration presents the location overview in the activity location map:

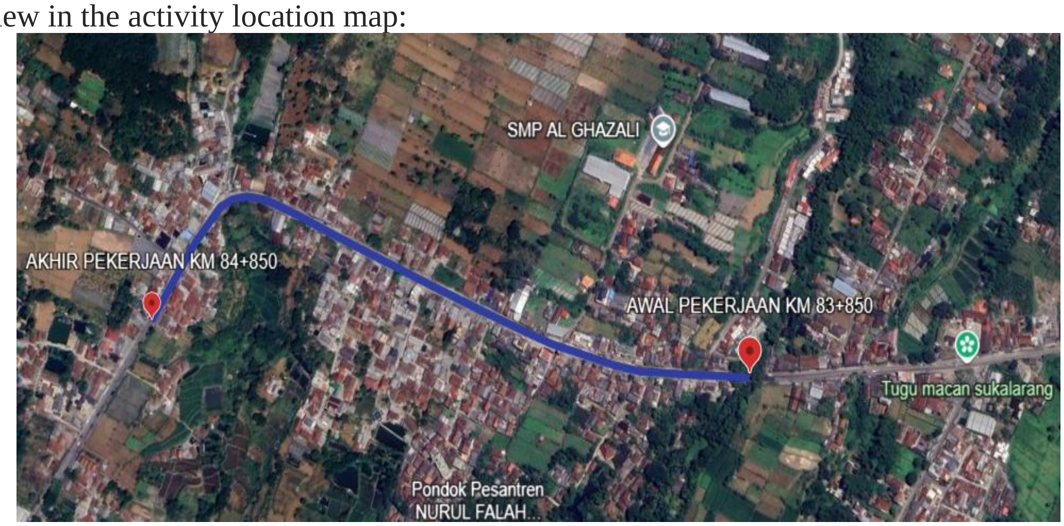

Figure 1. Research Location Map

The calculation results for the damaged area and its percentage are as follows:

1. KM. 83+850 – 83+930

Segment Length: 80 m
Segment Width: 7 m
Segment Area: 80 × 7 = 560 m²
There are two types of road damage identified:
a. Ravelling (50 x 7 = 350 m^2)
b. Patching (30 x 7 = 210 m^2)
The percentage of damage is calculated as follows:

Ravelling $= \frac{Damage\ Area}{Segment\ area} \text{x } 100\ \%$

$= \frac{350}{560} x 100\ \%$

$= 62.5\ \%$

Patching $= \frac{Damage\ area}{Segment\ area} \text{x } 100\ \%$

$= \frac{210}{560} x 100\ \%$

$= 37.5\ \%$

2. KM. 84+050 – 84+070 (Left Side)
Segment Length: 20 m
Segment Width: 3.5 m
Segment Area: 20 × 3.5 = 70 m²
There is one type of road damage identified:
a. Surface Layer Peeling (20 x 3.5 = 70 m^2)
The percentage of damage is calculated as follows:

Surface Layer Peeling = $= \frac{Damage\ Area}{Segment\ area} \text{x } 100\ \%$

$= \frac{70}{70} x 100\ \%$

$= 100\ \%$

3. KM. 84+230 – 84+250 (Right Side)
Segment Length: 20 m
Segment Width: 3.5 m
Segment Area: 20 × 3.5 = 70 m²
There is one type of road damage identified:
a. Potholes (20 x 3.5 = 70 m^2)
The percentage of damage is calculated as follows:

Potholes $= \frac{Damage\ Area}{Segment\ area} \text{x } 100\ \%$

$= \frac{70}{70} x 100\ \%$

$= 100\ \%$

4. KM. 84+250 – 84+310 (Right Side)
Segment Length: 60 m
Segment Width: 3.5 m
Segment Area: 60 × 3.5 = **210 m²**
There is one type of road damage identified:
a. Surface Layer Peeling (60 x 3.5 = 210 m^2)
The percentage of damage is calculated as follows:

Surface Layer Peeling = $\frac{Damage\ Area}{Segment\ area}$ x 100 %

$= \frac{210}{210} x 100\ \%$

= 100 %

5. KM. 84+750 – 84+850 (Left Side)
   Segment Length: 100 m
   Segment Width: 3.5 m
   Segment Area: 100 × 3.5 = **350 m²**
   There is one type of road damage identified:
   a. Cracking (100 x 3.5 = 350 m^2)
      The percentage of damage is calculated as follows:
      Cracking = $\frac{Damage\ Area}{Segment\ area}$ x 100 %x 100 %

      $= \frac{350}{350} x 100\ \%$

      = 100 %

A summary of all types of damage in each road segment is then compiled. The recap of the calculated damage values is presented in Table 1.

Table 1. Identification of Road Damage

KM	Type of Damage	Area Type of Damage (m2)	Percentage of Damage (%)	Number of Damages
KM. 83+850 – 83+930	Granular release	50	62.5	1
	Patching	30	37.5	1
	Total			2
KM 84+050 – 84+070 (Left Side)	Surface Layer Peeling	70	100	1
KM 84+230 – 84+250 (Right Side) KM 84+250 – 84+310 (Right Side)	Potholes Surface Layer Peeling	70 210	100 100	1 1
KM 84+750 – 84+850 (Left Side)	Surface Layer Peeling	350	100	1
Overall Total				6

The Average Daily Traffic (ADT) on the Cianjur–Sukabumi connecting road segment is obtained from the traffic volume presented in Table 2.

Table 2. Data LHR

Waktu	Jenis Kendaraan / Jam	Jenis Kendaraan / Jam	Ket

	Light Vehicle (LV)		Heavy Vehicle (HV)		(MC)	S	Light Vehicle (LV)		Heavy Vehicle (HV)		(MC)	S	
	MPV/Sedan/Jeep	Minibus /Light Truck	Bus/ 2-Axle Truck	3-Axle Truck	Motor cycle		MPV/Sedan/Jeep	Minibus /Light Truck	Bus/ 2-Axle Truck	3-Axle Truck	Motor cycle		
A	b		c		d	e	f = d*1		g = c*1.3		h=d*0.5	i	j
06.00-06.15	102	50	50	1	260	463	102	50	65	1.3	130	348.3	Peak Hour
06.15-06.30	82	37	10	1	240	370	82	37	13	1.3	120	253.3	
06.30-06.45	98	40	25	1	260	424	98	40	26	1.3	130	295.3	
06.45-07.00	95	45	25	0	295	460	95	45	32.5	0	147.5	320	
07.00-07.15	96	51	30	0	250	427	96	51	39	0	125	311	
07.15-07.30	75	30	28	1	315	449	75	30	36.4	1.3	157.5	300.2	
07.30-07.45	95	42	42	1	255	435	95	42	54.6	1.3	127.5	320.4	
07.45-08.00	81	40	40	1	265	427	81	40	52	1.3	132.5	310.8	
08.00-08.15	82	35	35	1	270	423	82	35	45.5	1.3	135	298.8	
08.15-08.30	90	32	32	1	280	435	90	32	41.6	1.3	140	304.9	
08.30-08.45	92	35	35	0	287	449	92	35	45.5	0	137.5	310	
08.45-09.00	95	44	44	0	269	452	95	44	57.2	0	134.5	330.7	
15.00-15.15	75	27	27	0	201	330	75	27	35.1	0	100.5	237.6	
15.15-15.30	80	19	19	0	210	328	80	19	24.7	0	105	228.7	
15.30-15.45	74	17	17	0	221	329	74	17	22.1	0	95	208.1	
15.45-16.00	70	11	11	0	180	272	70	11	33.8	0	90	204.8	
16.00-16.15	95	45	45	0	255	440	95	45	58.5	0	127.5	326	
16.15-16.30	105	48	48	1	257	459	105	48	62.4	1.3	128.5	345.2	
16.30-16.45	103	52	52	1	250	458	103	52	92.1	1.3	125	290.4	
16.45-17.00	114	51	51	0	255	471	114	51	104	0	127.5	302.9	
17.00-17.15	105	45	45	0	245	440	105	45	5.2	0	122.5	277.7	
17.15-17.30	118	40	8	1	230	397	118	40	40	0	115	283.4	
17.30-17.45	95	45	7	0	256	403	95	45	9.1	0	128	277.1	
17.45-18.00	90	45	5	1	210	351	90	45	6.5	1.3	105	247.8	
Total	2207	926	731	12	6016	9892	2207	926	1001.8	14.3	2986.5	6933.4	

Table 3. Road Class Values

Traffic Class	AADT (Average Annual Daily Traffic)
0	< 20

1	20-50
2	50-200
3	200-500
4	500-2.000
5	2.000-5.000
6	5.000-20.000
7	20.000-50.000
8	> 50.000

The highest traffic volume was recorded in the 06:00–06:15 interval with a total of 348.3 **vehicles** during its peak hour. Based on the Average Daily Traffic (LHR) calculation above, the daily traffic volume is 6,933.4 smp/day, which corresponds to traffic class 6. Traffic class is used to determine maintenance activities. The Road Condition Value (Nilai Kondisi Jalan) is the value assigned to the road. The Priority Order (Urutan Prioritas) is classified as follows:

Table 4. Road Priority Classification

No	Priority Order (UP)	Recommended Program
1	0 - 3	The road should be included in an upgrading/improvement program
2	4 – 6	The road should be included in a periodic maintenance program
3	> 7	The road should be included in a routine maintenance program

For the segment KM 83+850 – 83+930, the road condition value is 1, because the total damage score is 2.

UP = 17 – (LHR Class + Road Condition

The Priority Order (UP) for the segment KM 83+850 – 83+930 is calculated as follows:

= 17 – (6 + 1)
= 10

Thus, the priority order for KM 83+850 – 83+930 is 10, with the recommended treatment being routine maintenance. Based on the total calculation in the table above, the total road condition value is obtained as follows:

$$\text{Total Road Condition Value} = \frac{Total\ Damage\ Score}{Number\ of\ Segments}$$
$$= \frac{6}{5}$$
$$= 1.2$$

Therefore, the priority order for the entire road section of the Cianjur–Sukabumi connector at KM 83+850 – 84+850, with a total length of 1000 meters, is calculated as follows:

Priority Order=17−(Traffic Class (LHR)+Road Condition Value)
= 17 – (6 + 1.2)

= 9.8

Thus, the priority order for the Cianjur–Sukabumi connecting road section at KM 83+850 – 84+850 is 9.8, which places it in the routine maintenance program. Routine maintenance is performed continuously (this type of maintenance is carried out without waiting for significant damage and is preventive in nature). Road damages included in the routine maintenance program typically have moderate severity compared to those requiring periodic maintenance. Examples of damages handled under routine maintenance include potholes, hairline cracks, thin-layer deterioration, surface peeling, clogged drainage channels, faded road markings, malfunctioning street lighting, and others.

The findings of this study on the Cianjur–Sukabumi connecting road at KM 83+850 – 84+850 show that the dominant types of damage include ravelling (aggregate loss), surface peeling, potholes, and surface cracking, with an average road condition value of 1.2. These findings align with (Hadiyono et al., 2024; Stevano et al., 2023), who states that surface damages such as ravelling and patching are among the most frequent types occurring on flexible pavements exposed to high traffic loads and extreme weather conditions. With an AADT of 6,933.4 smp/day, the traffic load on this segment is considered heavy, supporting the presence of significant surface-related deterioration.

This study also reinforces the findings of Wardhana & Syahputra (2020), who emphasize that road damage is primarily influenced by two major factors: traffic intensity and drainage quality. In the study area, damages such as surface peeling and ravelling generally occur due to water infiltration into the pavement layers caused by suboptimal drainage performance. This is consistent with field observations showing several locations where side drains were not functioning properly, leading to water stagnation and accelerating surface layer deterioration.

Moreover, the dominance of surface-level damages with moderate to high severity supports the findings of (Rita & Carlo, 2019), who state that roads with high traffic volumes and inconsistent maintenance tend to show progression of surface deterioration within months to years. A similar pattern is observed at KM 84+050 – 84+310, where certain segments exhibited 100% surface damage, indicating that previous maintenance efforts may not have been effective in extending the service life of the pavement.

The Bina Marga method used in this study also aligns with research by (Sudirman, 2023), who concluded that the Road Condition Value (NKJ) calculation is the most relevant method for evaluating road damage in Indonesia, as it accurately represents road conditions based on damage type, severity level, and affected area. The NKJ value of 1.2 and the Priority Order (UP) of 9.8 indicate that this road segment falls into the routine maintenance category. This further confirms that the observed damages remain at the surface level and do not yet require structural improvement or major rehabilitation.

CONCLUSION

Based on field observations along the Cianjur–Sukabumi connecting road segment at KM 83+850 – 84+850, covering a total length of 1000 meters, several types of pavement distress were identified, including ravelling, patching, surface peeling, longitudinal cracking, potholes, and random cracking. The highest damage score was found at KM 83+850 – 83+930, with a total distress value of 6, consisting of ravelling and patching. The Average Daily Traffic (ADT) recorded on this segment was 6,933.4 smp/day, corresponding to traffic class 6, while the calculated road condition value was 1.2. The analysis using the Bina Marga method resulted in a Priority Order (UP) value of 9.8, indicating that the segment falls into the routine maintenance program. Routine maintenance activities include surface layer treatment, pavement repairs without increasing structural capacity, and continuous year-round maintenance actions.

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