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A Road Damage Analysis Using the Bina Marga Method (A Case Study of the Tapung–Tandun Road, STA 0+000 – STA 5+000, Kampar Regency, Riau Province

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Abstract. *The Tapung–Tandun road is a provincial highway that links Tapung District and Tandun region. This road falls under the classification of a third-class collector road, spanning 45.5 kilometers in length and featuring a 7-meter-wide carriageway. As transportation demands continue to rise on the Tapung–Tandun road, the increased vehicular traffic has not been met with commensurate infrastructure, leading to substantial surface damage. The objectives of this study were to determine the types of damage present on the flexible pavement of the Tapung–Tandun road, to evaluate the extent of road damage using the Bina Marga method, and to ascertain the average daily traffic flow along the Tapung–Tandun road. The method employed to analyze road damage on the Tapung–Tandun road was the Bina Marga method. The results of the road damage survey on this road in Kampar Regency revealed various types of damage, including cracks, potholes, aggregate loss, and rutting. The analysis of road damage using the Bina Marga method yielded the following percentages of damage: 3.748% for cracking from STA 0+000 to STA 5+000, 4.573% for potholes from STA 0+000 to STA 5+000, 5.848% for aggregate loss from STA 0+000 to STA 5+000, and 2.537% for rutting from STA 0+000 to STA 5+000. The analysis using the Bina Marga method determined a road maintenance program level of 3, indicating that the Tapung–Tandun road fell under the category of road improvement programs. The survey results for the average daily traffic (ADT) volume indicated a total of 5,113 PCU/day. Among various vehicle types, sedans, jeeps, and station wagons were the most prevalent on the Tapung–Tandun road, with a total of 2,029 PCU/day, while trucks with 4 axles (1.2-2.2) or trailers were the least common, with 27 PCU/day.*

Keywords: *Road Pavement, Bina Marga Method, Road Damage Analysis, ADT (Average Daily Traffic).*

INTRODUCTION

Roads constitute a vital component of ground transportation, playing a pivotal role in the lives of people, particularly in supporting economic growth and sociocultural development for the advancement of a nation. To facilitate the mobility of people and provide adequate services commensurate with the necessary capacity, any road damage can impede public activities and give rise to accidents. As the demand for road service levels continues to rise, there is a growing need for the enhancement of road quality and road infrastructure, including the necessity for safe and comfortable roadways. Based on the Republic of Indonesia Law No. 38/2004, Article 1, Paragraph 4, a road is defined as a ground transportation infrastructure encompassing all aspects of the road, including its complementary structures and equipment, designed for traffic located on the ground and/or water surfaces, as well as above water surfaces, with the exclusion of railway tracks, truck roads, and cable roads.

One of the categories of road pavement is flexible pavement. Flexible pavement comprises layers that are placed atop a compacted subgrade and employs asphalt as its surface

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layer or binding material. These pavement layers possess flexibility, ensuring a comfortable experience for vehicles as they traverse them (Sukirman, *Flexible Pavement Road*, 1999).

Road damage can manifest due to a multitude of factors, which should not be underestimated, as it can yield negative repercussions. When roads in certain regions sustain damage, the progress of life in other areas is also impeded. Road pavement stands as a critical component in maintaining the seamless flow of traffic. Examples of road damage encompass cracks, potholes, rutting, surface roughness, and depression.

The Tapung–Tandun road is a provincial highway that connects Tapung District and Tandun region. Tandun is the name of a PTPN V plantation area located within Tapung Hulu District. The Tapung–Tandun road has a length of 45.5 kilometers and a road width of 7 meters. It is a heavily traveled crossroad. This road is frequented by a variety of vehicles, including both light and heavy ones. The substantial presence of heavy vehicles on this road is due to the presence of major companies in the area, such as PTPN V (Indonesia's state plantation company) and PT Gas (PERTAMINA) (a subsidiary of Indonesia's state-owned oil and gas corporation). Moreover, this route is frequently used for transporting goods to and from Pekanbaru. With the increasing transportation demands, as observed on the Tapung–Tandun road at present days, the surge in the number of vehicles has not been matched with adequate infrastructure, notably the road surface, which has undergone considerable wear and tear. The condition of the road surface significantly impacts the vehicles traveling along it. Road damage cannot be attributed to a single factor alone. Various types of vehicles utilize this road, including both light and heavy vehicles with excess loads (overload), such as intercity buses and trucks carrying timber, oil palm shell transportation, crude palm oil (CPO) transportation, overloaded oil palm transportation, and more. Additionally, factors like road conditions, terrain contours, weather variations, and road planning and execution all contribute to road surface damage.

Based on the previously outlined background, this research addressed several issues. These include identifying the types of road damage present on the Tapung–Tandun road, determining the largest and smallest damage index values on the Tapung–Tandun road, and establishing the average daily traffic volume on the Tapung–Tandun road. The objectives of this research were to determine the types of damage on the flexible pavement surface at the research site, to analyze the extent of road damage using the Bina Marga method, and to calculate the average daily traffic volume on the Tapung–Tandun road.

METHODS

In this study, the researchers employed the Bina Marga method. It is an Indonesian approach that yields priority order and maintenance program formats based on values obtained from the priority order. This method combines values acquired from visual surveys, including the types of damage, and surveys of average daily traffic (ADT). Subsequently, it results in road condition values and ADT class values. The purpose of employing the Bina Marga method for road assessment is to evaluate the condition of the road pavement through visual surveys. This method reviews traffic volume and the types of damage occurring on the road surface. In the Bina Marga method, the types of damage to be considered during visual surveys are cracks, rutting, potholes, surface roughness, and depression. The assessment results of road pavement conditions are then used as references and alternative selections for repairing road damage.

The types and levels of each road surface damage are visually observed in segments of 100 meters along the road and conducted systematically. Surface damages are grouped, observed, coded, and evaluated.

The percentage value (PV) for each segment's damage can be calculated using the following formula:

$$PV = \frac{Area\ of\ Damage\ Type}{Segment\ Area} \times 100\%$$

The obtained percentage values can be categorized as shown in Table 1 below.

Table 1. Categories of Road Damage Percentage Values

Percentage	Category	Value
<5%	Very Few	2
5–20%	Few	3
20–40%	Moderate	5
>40%	Many	7

If the percentage value is less than 5%, it falls into the "Very Few" category with a value of 2. If the percentage value falls between 5% and 20%, it is categorized as "Few" with a value of 3. A percentage value between 20% and 40% is classified as "Moderate" with a value of 5, and a percentage value exceeding 40% is categorized as "Many" with a value of 7.

The road damage weight value represents the magnitude of the weight value obtained for each type of damage on the road surface, assessed based on the damage values, as shown in the table below.

Table 2. Road Damage Weight Value

No.	Types of Damage	Value
1	Patch	4.0
2	Crack	5.0
3	Aggregate Loss	5.5
4	Pothole	6.0
5	Rutting	6.0
6	Surface Roughness	6.5
7	Depression	7.0
8	Joint Filler Damage	7.0

Analysis of Road Conditions Using the Bina Marga Method

The determination of road condition values is carried out by summing the numerical values for each type of damage. The data analysis procedure using the Bina Marga method is as follows.

1. Identify the road type and road class.
2. Calculate the average daily traffic (ADT) and determine the road class using the following Table 3.

Table 3. Average Daily Traffic (ADT) and Road Class Values

ADT (in PCU/day)	Road Class Value
<20	0
20–50	1
50–200	2
200–500	3
500–2000	4
2000–5000	5
5000–20000	6
20000–50000	7
>50000	8

3. Group the survey data and adjust it according to the type of damage.
4. Calculate parameters for each type of damage and research each type of damage based on the following Table 4.

Table 4. Condition Scores Based on Types of Damage

1. Crack		
Type		**Score**
A	None	1
B	Longitudinal Pattern	1
C	Transverse Pattern	3
D	Random Pattern	4
E	Alligator Skin Pattern	5
Width		**Score**
A	None	0
B	<1 mm	1
C	1–2 mm	2
D	>2 mm	3
The Extent of Damage (Area)		**Score**
A	0	0
B	<10 %	1
C	10–30 %	2
D	>30 %	3
2. Rutting		
Depth		**Score**
A	None	0
B	0–5 mm	1
C	6–10 mm	3
D	11–20 mm	5
E	>20 mm	7
3. Patching and Potholes		
Extent		**Score**
A	<10 %	0
B	10–20 %	1
C	20–30 %	2
D	>30 %	3
4. Road Surface Roughness		
Types		**Score**
A	Close Texture	0
B	Fatty	1
C	Rough (Hungry)	2
D	Aggregate Loss	3
E	Joint Filler	4
5. Depression		
Types		**Score**
A	None	0
B	0–2 / 100 m	1
C	2–5 / 100 m	2
D	>5 / 100 m	3

5. Sum up the scores for all types of damage and determine the road condition value based on Table 5 below.

Table 5. Road Condition Values Based on Total Damage Score

Total Damage Score	Value
26–29	9
22–25	8
19–21	7
16–18	6
13–15	5
10–12	4
7–9	3
4–6	2
0–3	1

6. Calculate the priority order of road conditions, which is a function of the average daily traffic (ADT) class (road class value) and the road condition value.

   Priority Order = 17 – (Road Class Value + Road Condition Value)

The purpose of this priority order is to determine the appropriate type of treatment for the examined road's damage. The road maintenance programs listed in the Procedure for Road Maintenance Program Development No. 018/BNKT/1990, based on the priority order values, are as follows.

1. Priority order 0–3 indicates that the road should be included in the road improvement program;
2. Priority order 4–6 indicates that the road should be included in the periodic maintenance program;
3. Priority order >7 indicates that the road should be included in the routine maintenance program.

Research Equipment

The equipment used in this research included the following:

1. A 5-meter measuring tape, used to measure the road damage's width,
2. A 100-meter measuring tape, used to measure the road damage's length,
3. Survey forms, used for recording road damage data,
4. Writing tools, including pens, notebooks, and a hardboard for recording field research data,
5. A mobile phone camera, used for documentation during field research, and
6. PYLOX or paint, used to mark each STA (station).

Research Data

In this research, two types of data were required: primary data and secondary data. Primary data were collected or obtained directly during field surveys, while secondary data were obtained from existing sources.

1. Primary Data

   Primary data were collected through direct observations of the existing conditions at the research location.

2. Secondary Data

   Secondary data were obtained from existing sources, such as the reports of the Public Works Department, books, journals, and other relevant sources.

The data processed in this research were primarily from primary sources, specifically the data obtained from direct observation on the Tapung–Tandun road. The data used included as follows:

1. Data on the type and severity of road damage, and
2. Average daily traffic (ADT) data.

Research Stages

To analyze the issues investigated in this study, the researchers carried out four stages. These stages are as follows:

1. Preparation stage

The preparation stage involved activities conducted before initiating the data collection and processing stages. In this initial phase, important tasks were organized to optimize time and work efficiency. To commence the research, preparations were made for data collection, including research tools and materials (survey forms, writing tools, measuring instruments (i.e., tape measures), PYLOX/paint, vests, and a mobile phone camera).

2. Data collection stage

The data collection stage involved survey activities and data gathering related to the data requirements for analysis. In this research, the researchers conducted several phases.

Phase 1: Conducting a location survey to identify the research location and the length of the road to be examined.

Phase 2: Surveying road damage to identify the types of road damage at the research location.

Here are the steps taken during a road damage survey:

a. Collecting data regarding road damage, conducted by a team of four individuals, consisting of two people operating the measuring tape, one handling documentation, and one performing measurements for each type of damage;

b. Dividing each road segment into 100 meters;
c. Documenting each type of road damage;
d. Determining the severity level of each damage;
e. Measuring each segment with specific damage;
f. Recording the results on the prepared survey forms.

Phase 3: Collecting data on vehicle traffic (average daily traffic–ADT).

Here are the steps taken during an average daily traffic (ADT) survey:

a. Conducting observations with a team of four individuals, including one field coordinator;
b. Conducting observations in both directions;
c. Manually recording each type of passing vehicle as per the provided forms.

Average daily traffic (ADT) data for vehicles passing through the Tapung–Tandun road from two traffic directions were collected continuously for 24 hours a day over four days, starting from June 2, 2023, to June 5, 2023. This included both light and heavy vehicles using the road. The designated survey times were as follows:

a. Friday from 06:00 AM to 06:00 AM;
b. Saturday from 06:00 AM to 06:00 AM;
c. Sunday from 06:00 AM to 06:00 AM;
d. Monday from 06:00 AM to 06:00 AM.

3. Data processing stage

Data processing is the process of converting raw data into meaningful and useful information. Various sectors require data processing to ensure that information can provide a positive contribution. Data processing is carried out to facilitate the data analysis process. The data analysis in this research was conducted using the Bina Marga method. The data processing stage involved the following steps:

a. Analyzing the percentage of each road damage type at the research location;
b. Organizing the surveyed data into tables and categorizing the data by the type of damage;
c. Calculating the ADT for the surveyed road;
d. Determining the road type and class;
e. Calculating the priority order by summing up each type of damage and assigning a road condition value;
f. Determining the road maintenance program based on the analysis results.

4. Report writing and conclusion stage

This stage involved writing the research report following applicable guidelines and the results of data processing, as well as drawing conclusions based on the analyzed data. Conclusions were drawn based on the problem formulation. The flowchart of this research is depicted in Figure 1.

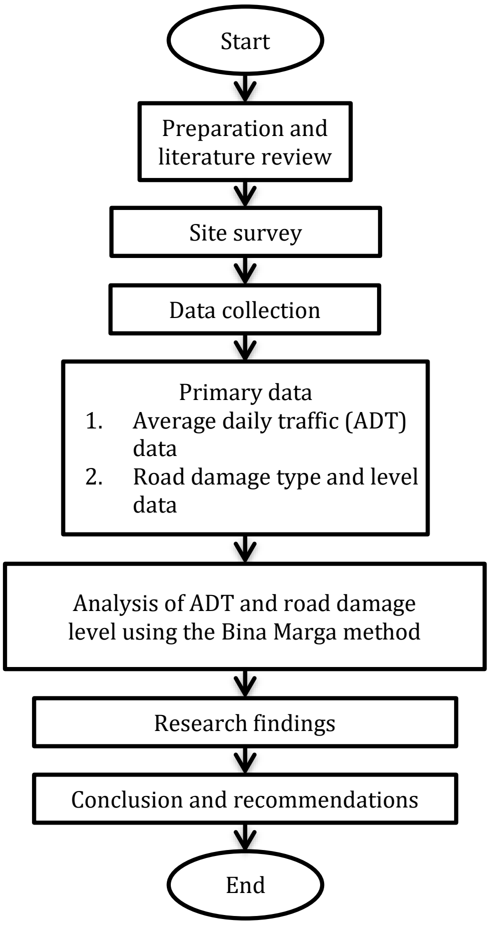

Figure 1. Research Flowchart

RESULTS AND DISCUSSION

Assessment of Road Damage Conditions Using the Bina Marga Method

Based on the data obtained in the field, the road's width is found to be 7 meters, and the length of the road under review is 5 km, with the initial stationing position at 0+000 and the final stationing position at 5+000. The road has one lane with two directions of travel. The reason for reviewing a 5 km stretch is that the most severe road damage on the Tapung–Tandun road is found in STA 0+000 – 5+000. Previously, severe damage was also present in STA 22+500 – 23+500 and STA 31+500 – 32+200, but road reconstruction has already been carried out in those locations. The length of each segment is divided based on the Bina Marga method, which is 100 meters per segment. It is then summarized every 1 km to determine which kilometer has the most severe damage.

Crack Damage

Crack damage is one of the issues on the Tapung–Tandun road. Crack damage allows water to penetrate, leading to increased weakening that can result in pavement surface disintegration, such as potholes (Nurdin, 2022). Based on the survey and analysis along the Tapung–Tandun road, two types of crack damage are identified.

1. Alligator Skin Cracking

Alligator skin cracking refers to small cracks resembling alligator skin, with a width of 3 mm or more. Based on the analysis, the total area of alligator skin cracking along the 5 km road is 121.95 m^2. A more detailed analysis of alligator skin crack damage can be seen in Table 6 below.

Table 6. Alligator Skin Crack Analysis Results

No	STA	Segment		Damage Area (m^2)	Damage Area (m^2/km)
		From	To		
1	0+000 – 1+000	0	100	6.6	28.85
2		100	200	7.25	
3		400	500	15	
4	1+000 – 2+000	200	300	2.55	13.05
5		600	700	4.5	
6		700	800	6	
7	2+000 – 3+000	500	600	6.75	32.15
8		700	800	14	
9		800	900	11.4	
10	3+000 – 4+000	500	600	14	14
11	4+000 – 5+000	500	600	27.5	33.9
12		800	900	6.4	
Total Damage Area Along 5 Km					121,95

2. Random/Corner Cracking

Random or corner cracking refers to cracks that are interconnected, forming large blocks with sharp corners or can be described as a series of block cracks (Nurdin, 2022). Based on the analysis, the total area of random/corner cracking from STA 0+000 to STA 5+000 on the Tapung–Tandun road is 140.43 m^2. A more detailed analysis of random/corner crack damage can be seen in Table 7 below.

Table 7. Random/Corner Crack Analysis Results

No.	STA	Segment		Damage Area (m^2)	Damage Area (m^2/km)
		From	To		
1	0+000 – 1+000	700	800	12.8	12.8
2	1+000 – 2+000	100	200	6.97	20.53
3		300	400	7.56	
4		400	500	6	
5	3+000 – 4+000	200	300	50.4	107.1
6		400	500	11	
7		500	600	21.7	
8		600	700	24	
Total Damage Area Along 5 Km					140.43

Based on the analysis results of crack damage on the Tapung–Tandun road, a simplified percentage distribution per kilometer is presented in Figure 2 below.

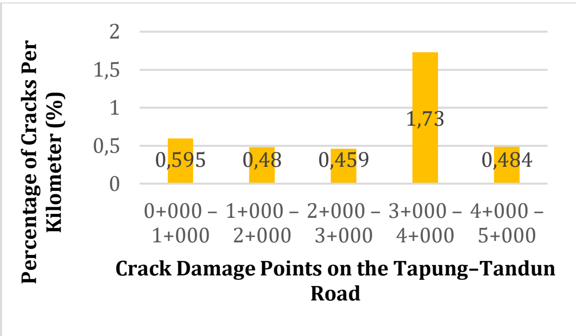

Figure 2. Percentage of Crack Damage Per Kilometer

From the graph above, it can be observed that the Tapung–Tandun road experiences the highest crack damage at STA 3+000 – 4+000, covering the segment from 0 to 1000 m with a damage percentage of 1.73%. The second position is occupied by STA 0+000 – 1+000, from the segment 0 to 1000 m with a percentage of 0.595%. The third position is held by STA 1+000 – 2+000 with a percentage of 0.48%, followed by STA 4+000 – 5+000 in the fourth position with a percentage of 0.484%. Finally, the last position is STA 2+000 – 3+000 with a percentage of 0.459%. Based on the crack analysis results, the total crack percentage along the 5 km road is 3.748%. Based on the percentage value table (refer to Table 1), it falls within the percentage category of <5%, which is categorized as “Very Few.” It results in a percentage value of 2. Furthermore, the crack damage weight value obtained from the road damage weight value table (refer to Table 2) is 5.0. These values can be analyzed further using the following formula.

Value of crack damage $= PV \times WV$

$= 2 \times 5.0$

$= 10$

Where:

PV = Percentage Value

WV = Weight Value

Therefore, the magnitude of crack damage is 10, categorized as "Very Few," with a damage percentage of 3.748%.

Pothole Damage

Potholes are one of the types of damage found on the Tapung–Tandun road. According to the survey and analysis conducted, the total area affected by pothole damage along approximately 5 kilometers is 320.1 m^2. A more detailed breakdown of the pothole damage analysis can be seen in Table 8 below.

Table 8. Pothole Damage Analysis Results

No	STA	Segment		Damage Area (m^2)	Damage Area (m^2/km)
		From	To		
1	0+000 – 1+000	0	100	6	16.24
2		400	500	1.12	
3		500	600	3	
4		700	800	3.92	
5		800	900	2.2	
6	1+000 – 2+000	100	200	16.2	103.76
7		300	400	3.96	
8		400	500	1	
9		500	600	24.8	
10		700	800	57.8	
11	2+000 – 3+000	400	500	6	30.4
12		600	700	20.4	
13		700	800	4	
14	3+000 – 4+000	100	200	13.4	77.2
15		200	300	5.2	
16		300	400	14	
17		500	600	9.2	
18		600	700	25	
19		800	900	10.4	
20	4+000 – 5+000	0	100	6.4	92.5
21		200	300	20.8	
22		300	400	14.7	
23		400	500	18	
24		600	700	1.6	
25		800	900	16	
26		900	0	15	
Total Damage Area Along 5 Km					320.1

Based on the analysis results of pothole damage on the Tapung–Tandun road, a simplified percentage distribution per kilometer is presented in Figure 3 below.

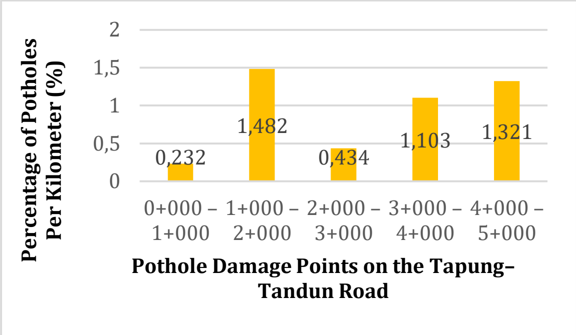

Figure 3. Percentage of Pothole Damage Per Kilometer

From the graph above, it is evident that the Tapung–Tandun road experiences the highest pothole damage at STA 1+000 – 2+000, spanning from segment 0 to 1000 m, with a damage percentage of 1.482%. The second position is occupied by STA 4+000 – 5+000, covering segments 0 to 1000 m, with a percentage of 1.321%. The third position is held by STA 3+000 – 4+000, with a percentage of 1.103%, followed by STA 2+000 – 3+000 in the fourth position with a percentage of 0. 434%. Finally, the last position is STA 0+000 – 1+000 with a percentage of 0.232%. Based on the pothole analysis results, the total pothole percentage along the 5 km road is 4.573%. Based on the percentage value table (refer to Table 1), it falls within the percentage category of <5%, which is categorized as "Very Few." It results in a percentage value of 2. Furthermore, the pothole damage weight value obtained from the road damage weight value table (refer to Table 2) is 6.0. These values can be analyzed further using the following formula.

$$\begin{aligned} \textit{Value of pothole damage} &= PV \times WV \\ &= 2 \times 6.0 \\ &= 12 \end{aligned}$$

Where:

PV = Percentage Value

WV = Weight Value

Therefore, the magnitude of pothole damage is 12, categorized as “Very Few,” with a damage percentage of 4.573%.

Aggregate Loss Damage

Aggregate loss is the separation of surface aggregates from the asphalt-aggregate mixture (Warrantyo, 2019). Based on the analysis, the extent of aggregate loss damage along 5 km of the Tapung–Tandun Road is 409.4 m^2. A more detailed analysis of aggregate loss damage can be seen in Table 9 below.

Table 9. Aggregate Loss Damage Analysis Results

No	STA	Segment		Damage Area (m^2)	Damage Area (m^2/km)
		From	To		
1	1+000 – 2+000	100	200	22.8	122.2
2		300	400	42	
3		500	600	40	
4		600	700	6	
5		700	800	11.4	
6	2+000 – 3+000	300	400	42	175.8
7		800	900	49.8	
8		900	0	84	
9	3+000 – 4+000	200	300	15.2	21.2
10		700	800	6	
11	4+000 – 5+000	200	300	65	90.2
12		600	700	15.2	
13		700	800	10	
Total Damage Area Along 5 Km					409.4

Based on the analysis results of aggregate loss damage on the Tapung–Tandun road, a simplified percentage distribution per kilometer is presented in Figure 4 below.

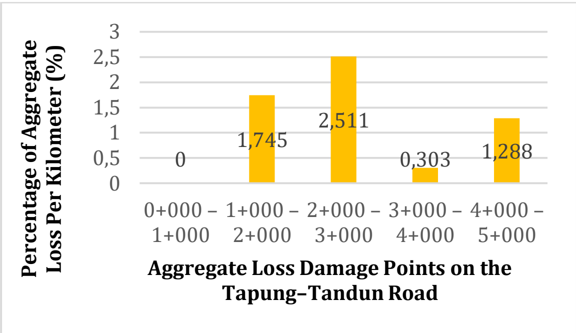

Figure 4. Percentage of Aggregate Loss Damage Per Kilometer

From the graph above, it can be observed that the Tapung–Tandun road experiences the highest aggregate loss damage at STA 2+000 – 3+000, covering the segment from 0 to 1000 m with a damage percentage of 2.511%. The second position is occupied by STA 1+000 – 2+000, from the segment 0 to 1000 m with a percentage of 1.745%. The third position is held by STA 4+000 – 5+000 from the segment 0 to 1000 m with a percentage of 1.288%. Finally, the last position is STA 3+000 – 4+000 with a percentage of 0.303%. Based on the aggregate loss analysis results, the total aggregate loss percentage along the 5 km road is 5.848%. Based on the percentage value table (refer to Table 1), it falls within the percentage category of 5–20%, which is categorized as "Few." It results in a percentage value of 3. Furthermore, the aggregate loss damage weight value obtained from the road damage weight value table (refer to Table 2) is 5.5. These values can be analyzed further using the following formula.

$$\begin{aligned} \textit{Value of aggregate loss damage} &= PV \times WV \\ &= 3 \times 5.5 \\ &= 16.5 \end{aligned}$$

Where:

PV = Percentage Value

WV = Weight Value

Therefore, the magnitude of aggregate loss damage is 16.5, categorized as "Few," with a damage percentage of 5.848%.

Rutting Damage

Rutting is a type of damage that occurs on the wheel path aligned with the road axis, which is caused by a less dense pavement layer. The causes of this damage may include an excessively high asphalt content, excessive use of fine aggregates, the use of rounded and smooth-surfaced aggregates, or asphalt with high penetration. Based on the analysis, the extent of rutting damage along 5 km of the Tapung–Tandun Road is 178.5 m^2. A more detailed analysis of rutting damage can be seen in Table 10 below.

Table 10. Rutting Damage Analysis Results

No	STA	Segment		Damage Area (m^2)	Damage Area (m^2/km)
		From	To		
1	1+000 – 2+000	300	400	8.4	22.4
2		600	700	11.5	
3		700	800	2.5	
4	2+000 – 3+000	200	300	39.6	75.6
5		700	800	36	
	3+000 – 4+000	100	200	8.8	43.2
6		300	400	20.5	
7		600	700	9.9	
		800	900	4	
8	4+000 – 5+000	300	400	28	37.3
		600	700	9.3	
Total Damage Area Along 5 Km					178.5

Based on the analysis results of rutting damage on the Tapung–Tandun road, a simplified percentage distribution per kilometer is presented in Figure 5 below.

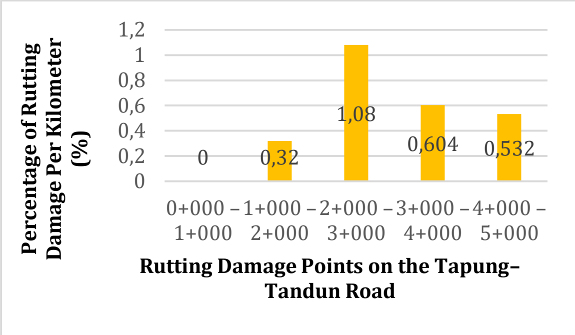

Figure 5. Percentage of Rutting Damage Per Kilometer

From the graph above, it can be observed that the Tapung–Tandun road experiences the highest rutting damage at STA 2+000 – 3+000, covering the segment from 0 to 1000 m with a damage percentage of 1.08%. The second position is occupied by STA 3+000 – 4+000, from the segment 0 to 1000 m with a percentage of 0.604%. The third position is held by STA 4+000 – 5+000 with a percentage of 0.532%. Finally, the last position is STA 1+000 – 2+000 with a percentage of 0.32%. Based on the rutting damage analysis results, the total rutting damage percentage along the 5 km road is 2.537%. Based on the percentage value table (refer to Table 1), it falls within the percentage category of <5%, which is categorized as "Very Few." It results in a percentage value of 2. Furthermore, the rutting damage weight value obtained from the road damage weight value table (refer to Table 2) is 6.0. These values can be analyzed further using the following formula.

$$\begin{aligned} \textit{Value of rutting damage} &= PV \times WV \\ &= 2 \times 6.0 \\ &= 12 \end{aligned}$$

Where:

PV = Percentage Value

WV = Weight Value

Therefore, the magnitude of rutting damage is 12, categorized as "Very Few," with a damage percentage of 2.537%.

Traffic Volume

An important parameter in pavement structural analysis is traffic data required to calculate the planned traffic load that the pavement will bear during its design life. The results of the analysis of the average daily traffic (ADT) volume on the Tapung–Tandun road in

Kampar Regency, collected over four days (Friday, Saturday, Sunday, and Monday), are summarized in Table 11 below.

Table 11. The Average Daily Traffic (ADT) Volume on the Tapung–Tandun Road

Category	Vehicle Type	ADT for Two Traffic Directions
2	Sedan, Jeep, and Station Wagon	2029
3	Passenger Car	158
4	Pick-up and Micro Truck	1037
5a	Small Bus	47
5b	Large Bus	76
6a	2-Axle 4-Tire Truck	69
6b	2-Axle 6-Tire Truck	733
7a	3-Axle Truck	856
7b	4-Axle 1.1.2.2 Truck	81
7c	4-Axle 1.2-2.2 Truck	27
Total Vehicles		**5113 PCU/day**

The results of the average daily traffic (ADT) survey show that the most frequently traversed vehicles on the Tapung–Tandun road are sedans, jeeps, and station wagons, totaling 2029 PCU/day. On the other hand, the least traversed vehicles on the Tapung–Tandun road are the 4-Axle 1.2-2.2 trucks, with only 27 PCU/day.

Priority Order

The priority order is utilized as a reference for determining the required treatment for a pavement based on the Bina Marga method. Its function is to identify the suitable type of intervention for a road experiencing damage. The road maintenance programs specified in the Procedure for Road Maintenance Program Development No. 018/BNKT/1990, based on the priority order values, are as follows:

1. Priority order 0–3 indicates that the road should be included in the road improvement program;
2. Priority order 4–6 indicates that the road should be included in the periodic maintenance program;
3. Priority order >7 indicates that the road should be included in the routine maintenance program.

After conducting the average daily traffic (ADT) and road damage surveys on the Tapung–Tandun road, which spans 5 kilometers, several types of damage were identified, including cracks, potholes, aggregate loss, and rutting. Additionally, the ADT condition along the road is 5113 PCU/day. Based on the ADT and road class value according to the Bina Marga method, an ADT of 5113 PCU/day corresponds to a road class value of 6. E

Table 12. ADT and Road Class Value

No	ADT (in PCU/day)	Road Class Value
1	<20	0
2	20–50	1
3	50–200	2
4	200–500	3
5	500–2000	4
6	2000–5000	5
7	5000–20000	6
8	20000–50000	7
9	>50000	8

In determining the condition score based on the types of damage present on the Tapung–Tandun road, reference is made to Table 4. For alligator skin pattern cracks, the value is 5, while random pattern cracks are assigned a value of 4. Cracks wider than 2 mm are assigned a value of 3, and areas with crack damage less than 10% receive a value of 0. For potholes, areas with damage less than 10% are assigned a value of 0. Surface roughness with aggregate loss is given a value of 3 while rutting damage with a depth of 11-20 mm receives a value of 5. To calculate the priority priority on the Tapung–Tandun road, the necessary data are summarized in Table 13 below.

Table 13. Determining the Condition Score Based on Types of Damage, ADT, and Road Class Value (Results of Data Observation Analysis)

<table>
<tr><th>No</th><th>ADT (in PCU/day)</th><th>Road Class Value</th><th>Type of Damages</th><th>Value</th></tr>
<tr><td>1</td><td rowspan="7">5113</td><td rowspan="7">6</td><td>Alligator Skin Pattern Cracks</td><td>5</td></tr>
<tr><td>2</td><td>Random Pattern Cracks</td><td>4</td></tr>
<tr><td>3</td><td>A Crack Width of >2 mm</td><td>3</td></tr>
<tr><td>4</td><td>A Crack Area of <10%</td><td>1</td></tr>
<tr><td>5</td><td>A Pothole Area of <10%</td><td>0</td></tr>
<tr><td>6</td><td>Aggregate Loss</td><td>3</td></tr>
<tr><td>7</td><td>Rutting Damage of 11–20 mm</td><td>5</td></tr>
<tr><td colspan="4">Total Condition Score</td><td>21</td></tr>
</table>

From the table above, it is evident that the ADT is 5113 PCU/day, with a road class value of 6. The total score based on the types of damage is 21. Therefore, as shown in Table 14 below, the road's condition value is 7.

Table 14. Road Condition Value

Road Condition Assessment	
Total Score Based on Types of Damage	**Road Condition Value**
26–29	9
22–25	8
19–21	7
16–18	6
13–15	5
10–12	4
7–9	3
4–6	2
0–3	1

Hence, the priority order can be calculated as follows:

Priority Order =17 – (*Road Class Value* + *Road Condition Value*)

Where:

Road Class Value= 6

Road Condition Value= 7

Therefore, *Priority Order* = 17 – (6 + 7) = 4

Based on the analysis of the priority order used to determine road maintenance programs, a priority order result of 4 was obtained. This indicates that the Tapung–Tandun road needs a periodic maintenance program. Without regular maintenance, there is a concern that the road will deteriorate rapidly, particularly because of being traversed by heavy-loaded vehicles.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

After researching the Tapung–Tandun road in Kampar Regency regarding road damage analysis based on the Bina Marga method, the researchers can draw the following conclusions from the study:

1. The survey of road damage on the Tapung–Tandun road in Kampar Regency revealed several types of damage, including cracks, potholes, aggregate loss, and rutting.
2. The analysis of road damage using the Bina Marga method indicated the following: Cracks on the road section from STA 0+000 to STA 5+000 had a damage level of 3.748%, falling into the category of “Very Few”. Potholes on the same road section had a damage level of 4.573%, also falling into the category of “Very Few”. Aggregate loss on the road section from STA 0+000 to STA 5+000 had a damage level of 5.848%, falling into the category of

"Few". Furthermore, rutting damage on the road section from STA 0+000 to STA 5+000 had a damage level of 2.537%, falling into the category of "Very Few." Among these, the aggregate loss had the highest damage percentage at 5.848% while rutting had the lowest damage percentage at 2.537%. Based on the priority order analysis used to determine road maintenance programs, a priority order result of 4 was obtained, indicating that the Tapung–Tandun road should be included in the periodic maintenance program.

3. The survey and analysis of the average daily traffic (ADT) data on the Tapung–Tandun road in Kampar Regency revealed a total of 5113 PCU/day. The most frequently observed vehicles on this road were sedans, jeeps, and station wagons, with a total of 2029 PCU/day. In contrast, the least frequently observed vehicles were 4-Axle 1.2-2.2 trucks, with a total of 27 PCU/day.

Recommendations

Based on the research findings and discussions, the researchers would like to provide the following recommendations:

1. It is essential to promptly address the road damage on the Tapung–Tandun road to reduce the risk of accidents and ensure the safety of road users. Implementing a periodic maintenance program on the Tapung–Tandun road section is advisable to prevent more severe damage from occurring.
2. In this study, an analysis of the average daily traffic (ADT) on the Tapung–Tandun road has been conducted. However, for future research, it is recommended to perform a reanalysis of the average daily traffic (ADT) to obtain updated annual ADT values for the Tapung–Tandun road.

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