ANALYSIS OF FACTORS CAUSING ROAD DAMAGE (CASE STUDY OF JALAN JULIUS USMAN KOTA TANJUNGBALAI)

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Abstract

Road is a land transportation infrastructure that is very important in facilitating other economic and social relations activities. However, if there is damage to the road, it will result not only in obstructing other economic and social activities, but also by accidents for road users. This study aims to determine the types of road damage, factors that cause damage to roads and solutions to overcome the damage that occurs.

The method used is field research with primary data in the form of the results of a survey of damage on the Jalan Julius Usman Kota Tanjungbalai section. The survey results on the types of road damage on the Jalan Julius Usman Kota Tanjungbalai section are winding crack damage, longitudinal cracks, edge cracks, patches, holes, collapse, large cracks, crocodile cracks, angular cracks, weathering and loose granules.

Factors that cause general road damage are increased traffic volume loads, poor drainage systems, poor material properties of pavement construction, climate, unstable soil conditions, very thin pavement planning, inappropriate work processes with specifications. Corrective actions that can be taken, namely actions per segment.

Keywords: *Factor Cause; Road damage.*

A. Introduction

The level of damage to severe flexible road pavement is not a strange sight especially in the area of Jalan Julius Usman, Tanjungbalai City. The unfamiliar view will not change for the better if it is not immediately anticipated or a solution is soon found to overcome the influence factors that cause damage to the flexible flexible pavement. The factors that influence the causes of road damage are most often considered to be a problem for the community including high rainfall in the area of Julius Usman, Tanjung Bulai City, drainage system factors that are not functioning well and also the percentage of heavy vehicles passing on a road . In addition to these factors there may still be many other influencing factors. However, the writing of this thesis will focus on the influence factors. High rainfall factors are included in one of the factors affecting the damage to flexible highway pavement.

Some roads, especially flexible highway pavements in the area of Jalan Julius Usman, Tanjung Bulai City, suffered severe damage, which disrupted the comfort of the drivers of motorized vehicles. The level of road damage due to high rainfall as described previously, may also be supported by a functioning drainage system factor. As is known that the function of the drainage channel is a means to accommodate water, especially rain water so that the rain water does not collect or concentrate on the road. If the water is not properly transferred due to the drainage system that is not functioning properly, it is feared that the water will enter the asphalt pavement layer and little by little it will damage the layer above it. In addition to these two factors, the percentage of heavy vehicles passing on a road is also one of the factors that is quite influential on damage to flexible highway pavement. For example, the level of damage to flexible pavement is quite severe which is allegedly due to the burden of heavy vehicles on the julius usman road segments.

B. Method

Classification of data

The first step in this research is to classify data. This data classifier is carried out with the aim of facilitating data processing later. As explained in the previous chapter, the independent variables that will be used for this study are rainfall, heavy vehicle percentage and also the drainage system. While the dependent variable used is a factor influencing the age of the research location.

Rainfall

Each region has a different level of rainfall. Therefore a parameter is needed to facilitate data processing later. Thus the data collection is needed. In this case the rainfall data is classified into three categories, namely:

1. High rainfall
2. Medium rainfall
3. Low rainfall

Percentage of heavy vehicles

The level of road damage is also affected by the number of heavy vehicles passing on the road. Therefore, the selection of the location of the survey is also based on the percentage of heavy assets themselves. The percentage of heavy vehicles is also divided into 2 categories, namely:

1. Percentage of high heavy vehicles
2. Percentage of low heavy vehicles

Data collection methods

This data collection is closely related to the survey method that will be carried out in this study. The selection of survey methods is very important in an effort to achieve efficiency from the entire survey. The method chosen must meet the research objectives and take into account the availability of available resources. The contents of the study are also limited by the basic data needed for further analysis in the study.

1. Rainfall

   Rainfall data is secondary data which will later request assistance from related agencies regarding the data, in this case the relevant agency is the Meteorology and Geophysics Agency (BMG). This rainfall data collection is carried out in order to determine the area with high, medium, and low rainfall categories. The data collection is expected to obtain rainfall data for a time range of about 5 years, so that the classification can be valid and can represent the rainfall level for the next few years. According to the guidelines for determining flexible pavement thickness using the component analysis method issued by the Director General of Highways, the category of rainfall is divided into 2, namely:

   a. High rainfall →> 600 mm / year
   b. Low volume bulk → <600 mm / year

   However, the classification standard is believed to be quite high and it may be very difficult to find the condition of the area that is at that standard. Especially for areas with high rainfall. Therefore, in this thesis research

another method will be used to classify rainfall categories. Classification will be discussed in the next chapter.

2. Percentage of heavy vehicle
   Data on the percentage of heavy vehicles is primary data, namely the traffic counting method. This method is also carried out based on interviews with local residents residing in the area with the damaged road section. In this case, what is said to be a heavy vehicle are as follows:
   a. Heavy Vehicle (HV): Truck, Dunp Truck, and others.
   b. Lightweight Vehicle (LV): Private Car, Pick Up, etc.
   c. Motorcycle (MC) This traffic counting method consists of two types, namely:
   d. Traffic counting to calculate road capacity In the traffic counting method this is done by counting the number of vehicles per hour, so that the characteristics of traffic per hour are known through the road. Usually this method is carried out to analyze the capacity or capacity of the road to the characteristics of existing traffic.
   e. Traffic counting to calculate the structural value of the pavement This method is different from traffic counting to calculate road capacity. This method does not have to be done for every hour, because the traffic characteristics for each hour are not very important.

3. Age of road pavement
   Data on the age of road pavement is secondary data that will be obtained through several agencies, both government agencies such as the Directorate General of Highways, DPU or other related parties. The age of the pavement is assessed in units of months and is calculated since the pavement was built or since the pavement was overlayed until the pavement has caused inconvenience to the users of motorized vehicles in driving their vehicles.

Identification of Research Locations

This research was conducted in Kota Tanjungbalai, Asahan Regency. With location on the road Julius Usman Kota Tanjungbalai. This study aims to see what are the main causes of road damage.

Data Processing Methods

In this study, data processing will be done using linear regression modeling. In this case, it will be known the relationship between the influence of road age

factors on rainfall variables and the percentage of heavy vehicles. There are several computer software that can calculate correlations, between Microsoft Exel and the same formula principle with manual correlation calculations. The output table form of the correlation calculation described above:

Table 1 Examples of correlation tables

	Y	X_1	X_2	X_3
Y	1	.....	.....	.....
X_1	.....	1	.....	.....
X_2	.....	.....	1	.....
X_3	.....	.....	.....	1

Information :

The number 1 diagonal indicates that the correlation between the Y and Y variables (the same variable) is very perfect. And the column that contains (...) will be filled with the correlation value that has been obtained from the calculation results.

By using linear regression modeling, it will be able to output the model as below.

$Y = a_o + a_1X_1 + a_2 X_2 + a_3 X_3$

Information :

Y = Related variables → Factors affecting road age

X_1 = Independent variable 1 → Rainfall

X_2 = Independent variable 2 → Percentage of heavy vehicle

X_3 = Independent variable 3 → Drainage system

a_o a_1 a_2 a_3 = Correlation Coefficient

C. Research Finding

Factors Causing Road Damage

Basically, road damage will not occur without triggering factors such as vehicles that exceed bad loads and construction. Road construction planning is based on the forecast traffic load that passes by converting the vehicle into a passenger car unit (SMP), the load per vehicle wheel, and the number of vehicle wheels. The cumulative load of traffic is an input to calculate the strength of the layers of road construction. In accordance with the function of the road, the maximum load is set between 8 tons and 12 tons, so that theoretically the service life of the road can be calculated. According to the Four Factor method, the addition of load per vehicle wheel results in a damage rate of the fourth power ratio between the real load 2 hra which works and the standard load. That is, the addition of these loads will greatly affect the service life of the road which becomes much shorter due to the

fourth power factor. Immediate early damage can occur, if the traffic load exceeds the standard load plan. In relation to the characterization of heavy vehicles, the effects of inertia and friction on suspension components are very important although most numerical simulations do not ignore them as a trade-off between model accuracy and computational efficiency.

Road user behavior that impacts shortening the service life of road construction is influenced by the desire to transport goods as much as possible for each vehicle. Various factors are the reason for road users to carry larger loads, especially heavy vehicles such as trucks, containers, and other heavy vehicles. The damage occurs faster because the load concentration on each vehicle wheel is very high due to the limited number of axles, because the vehicle wheel configuration still refers to the truck design for normal loads. The behavior of the truck drivers or entrepreneurs prioritizes efficiency from a lower transportation cost perspective. The loss suffered due to road damage is the final consideration. Even though in time if the road is damaged and results in a decrease in speed, the transportation costs will be even higher. Costs that must be borne are not only transportation costs but also include the cost of damage to the vehicle which is very likely to occur due to the shock and instability of vehicle movements.

In addition, many early damages to damaged road pavement have also been found, which can be attributed to general errors in the implementation of the road, which caused a lot of road damage before service life was passed. These errors include determining the type of asphalt used, the level of asphalt, cavities in the mixture, mixing temperature or compaction. Asphalt as an aggregate binder for road pavement where quality and quantity have a large contribution to the occurrence of road damage. The lack of thick asphalt / asphalt content in the mixture can result in rapid bitumen hardening. This will make road construction worse and weathering will occur quickly.

According to the research, there are several factors that can cause the asphalt road to break quickly, including:

1. The quality or quality of the asphalt road is not good, this can be because the material used is not good or outside the technical provisions, the method of construction is not good, work that coincides with the weather that is not right or rain for example and others.
2. Excessive loads, the heavier the cargo will accelerate the process of road damage, especially if for example the quality or quality of the road is not good, it will automatically accelerate the process of road damage.

3. Water flowing in the road or there is no channel, because according to experience, the road which has a poor drainage system will more quickly damage the road. It could also be because the water that was pooling on the road was like we saw on the Jalan Julius Usman.
4. For asphalt roads that are on Julius Usman's road, road damage can also be due to environmental factors. Roads that are less light or rarely exposed to sunlight so that when it rains or is exposed to water can not immediately disappear, the road can also become moist.

Decrease in utility cut depression

Decrease in utility cut depression. Occurs throughout the former planting of utilities. This happens because compaction does not meet the requirements.

Table 2 Comparison of Types of Road Damage

No.	Type of damage	Large (M^2)	% Damage
1	Winding cracks	100.7 m^2	38.99 %
2	Long cracks	92.65 m^2	18.38 %
3	Weathering and Loose Granules	84 m^2	16.71 %
4	Cracked crocodile skin	65.70 m^2	13.08 %
5	Edge cracks	20 m^2	3.98 %
6	Patch	16.30 m^2	3.84 %
7	Criss-crossed	14.02 m^2	2.81 %
8	Hole	3 m^2	0.60 %
9	Clear	1.45 m^2	0.39 %
10	Crack Angle	0.160 m^2	0.49 %
	Total	397.98 m^2	100.00 %

Source: Processed Data

The biggest type of damage that occurred on the road, which is a broken meandering crack of 100.7 m^2 or 38.99% of the total damage that occurred along the road which caused very uncomfortable for motorists to use the road, both mild, moderate and severe damage. This happened due to the development of other types of damage that were not immediately handled, the influence of weather (especially rain) and vehicle traffic which accelerated the formation of holes, and the smallest damage that occurred was broken crack angle of 0.160 m^2 or 0.49% which caused by a lack of lateral support (from the shoulder), poor drainage, shrinkage of the surrounding soil and the shoulder of the road down to the surface of the pavement.

D. Discussion

Analysis of Traffic Survey Results

The percentage of heavy vehicles on the Julius Usman road is quite high so that there is a high potential for many vehicles that violate the allowable maximum which can cause damage to roads and decrease the age of road plans or fluctuations in vehicle traffic flow. There are also those that are done for 3 days, namely Saturday, Sunday, Monday. Which represents 5 working days (July 25 to July 27, 2014), the duration of the survey is 12 hours or covers 12% from 08.00-18.00 WIB with a time interval of 1 hour.

Table 3 Vehicle Traffic Volume Per hour on each day and time.

Day	Observation time	Average Vehicle Middle School per Hour			
		Heavy vehicles (HV)	Light vehicles (LV)	Motorcycle (MC)	Total Vehicle
Saturday	08.00 - 12.00	8	50	115	173
	13.00 - 18.00	8	50	95	153
Sunday	08.00 - 12.00	4	41	81	126
	13.00 - 18.00	4	10	86	100
Monday	08.00 - 12.00	9	20	111	140
	13.00 – 18.00	9	35	110	154

Source: Processed Data

From the table data, the average number of observation days (Saturday, Sunday, Monday) of the total number of observation times (two observation time points) is made, with the following calculations:

From the above calculation, it can be seen that the highest daily traffic on average is Monday, which is 154 pcu / hour. This shows that the road of Julius Usman Kota Tanjungbalai still meets the standards set by Bina Marga, namely for

Saturday = (173 + 153) / 2 = 163 pcu / hour

Sunday = (126 + 100) / 2 = 113 pcu / hour

Monday = (140 + 154) / 2 = 147 pcu / hour

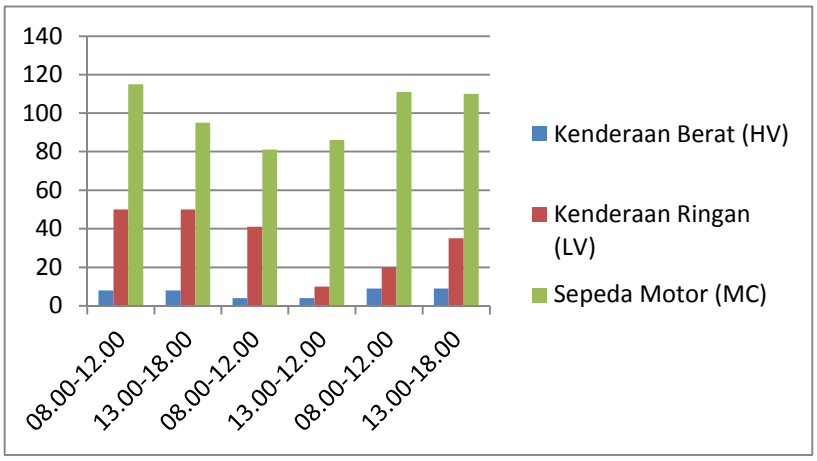

Figure 1 Fluctuations in vehicle traffic flow (vehicle / hour)

Capacity Analysis of the Indonesian Road Section

Analysis of road capacity in Indonesia is distinguished for urban roads, out-of-town roads and highways. As a guide to differentiating between urban roads and out-of-town roads, MKJI books provide characteristics / characteristics of urban / semi-urban roads that can be seen from:

1. There is a region built permanently and continuously throughout all or almost all roads, minimum on one side of the road.
2. Roads in urban areas with a population of more than 100,000 people are always classified in this group.
3. Roads in urban areas with a population of less than 100,000 people are classified in this group, if they have a permanently and permanently built area as described in point (1)
4. Has a higher characteristic of peak morning and evening traffic flow, and the composition of motorcycle traffic and private vehicles is very dominant, while the composition of truck types is low.

R.J. Salter (1974) defines capacity as:

"Capacity has been defined as the flow which produces the minimum acceptable speed journey and also the maximum traffic volume for comfortable free flow conditions."

Whereas MKJI (1997) defines capacity as the maximum current through a point on the road that can be maintained per hour unit under certain conditions. For two-way two-lane roads, capacity is determined for two-way flows (two-way combination), but for roads with multiple lanes, flows are separated by direction and capacity is determined per lane.

The basic equation for calculating road capacity in MKJI (1997) is as follows: **Urban**

Road:

$C = Co \times FCw \times FC_{SP} \times FC_{SF} \times FC_{CS}$

Road Outside the City:

$C = Co \times FCw \times FC_{SP} \times FC_{SF}$

Freeway:

$C = Co \times FCw \times FC_{SP}$

Where:

C = road capacity (smp / hour)
Co = basic capacity (smp / hour)
FCw = factor in adjusting the width of the traffic lane
FC_{SP} = adjustment factor of direction separation
FC_{SF} = adjustment factor due to side barriers
FC_{CS} = city size adjustment factor

Base capacity (Co) is determined by referring to the table:

Table 4 Basic Capacity of Roads

Road Type	Tipe Alinyemen	Basic Capacity (junior / hour)			Note
		Urban Roads	Out of Town Road	Freeway	
Six or four divided lanes or one-way roads	Flat	1.650	1.900	2.300	Per lane
	Hill		1.850	2.250	
	Mountain		1.800	2.150	
Four undivided lanes	Flat	1.500	1.700		Per lane
	Hill		1.650		
	Mountain		1.600		
Two undivided lanes	Flat	2.900	3.100	3.400	Total two way
	Hill		3.000	3.300	
	Mountain		2.900	3.200	

Source: 1997 Indonesian Road Capacity Manual

Type of road alignment outside the city and freeway is determined by referring to the criteria presented in table 5

Table 5 Criteria for Determining Alignment Types

Tipe Alinyemen	Up + down (m/km)	Horizontal arch (rad/km)
Flat	< 10	< 1.0
Hill	10-30	1.0 -2,5
Mountain	> 30	> 2.5

Source: MKJI, 1997

The capacity adjustment factor for traffic lane width (FCw) is determined by referring to table 6

Table 6 Capacity Adjustment Factors for Traffic Line Width (FCw)

Road type	Effective traffic lane (Wc) (m)	FCw		
		Urban Roads	Out of Town Road	Freeway
Six or four divided lanes or one-way roads (6/2 D) or (4/2 D)	Lane			
	3.00	0.92	0.91	
	3.25	0.96	0.96	0.96
	3.50	1.00	1.00	1.00
	3.75	1.04	1.03	1.03
	4.00			
Four undivided lanes (4/2 UD)	Lane			
	3.00	0.91	0.91	
	3.25	0.95	0.96	
	3.50	1.00	1.00	
	3.75	1.05	1.03	
	4.00			
Two undivided lanes (2/2 UD)	Total two way			
	5.0	0.56	0.69	
	6.0	0.87	0.91	
	6.5			0.96
	7.0	1.00	1.00	1.00
	7.5			1.04
	8.0	1.14	1.08	
	9.0	1.24	1.15	
	10.0	1.29	1.21	
	11.0	1.34	1.27	

Source: MKJI, 1997

E. Conclusion

Based on the results of the analysis and discussion of this research, some conclusions can be drawn as follows:

1. Based on the survey of road conditions the type of damage that occurred on the Julius Usman City of Tanjungbalai road is a 2m² hole, cracks extending 92.65m², crocodile skin cracks 65.70m², 100.7m² winding cracks, 20m² edge cracks, 16.30m² patches, weathering and granules loose 84m². The most

dominant types of damage are winding cracks, and loose grains caused by stagnant water rising to the bottom of the road so that the road is very easily damaged.

2. Based on the type of damage that occurs in the field, corrective actions can be taken immediately so that access roads can be passed easily and safely.

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