The Analysis of Road Condition on the Performance of Muara Teweh – Puruk Cahu Road Section

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Abstract*— *The existing condition of Muara Teweh-Puruk Cahu road section with ± 100 km long is mostly uphill and bend that currently is experiencing significant damage. This study aims to determine the type of damage in Muara Teweh-Puruk Cahu road section and to analyze the correlation between damage and vehicle speed on flat roads and hilly terrain.

The study was conducted by collecting primary data in the form of data of road damage, vehicle speed, and road geometric. Data analysis of road damage is done by the BinaMarga method to obtain the type of damage. The correlation between road damage and vehicle speed is shown in a regression model.

The results of the analysis show the vehicle speed will tend to decrease as the increasing number of road damage. The speed of light vehicles on roads with flat terrain shows a very strong correlation with the type of damage, such as cracks, grooves, and depression. The speed of light vehicle going uphill shows a very strong correlation with the type of damage, such as cracks, grooves, potholes, and depression. Meanwhile, when the vehicle goes downhill, it is seen a strong correlation with the types of damage such as cracks, grooves, and depression. The speed of heavy vehicles on roads with flat terrain shows a very strong correlation with the type of damage like cracks, grooves, potholes, and depression. The speed of heavy vehicle when going uphill shows a very strong correlation with the type of damage like cracks, grooves, potholes, and depression. Meanwhile, when the vehicle goes downhill, it is shown a very strong correlation with the types of damage like cracks, grooves, and depression.

***Keywords*— Road Damage, Vehicle Speed, Regression Analysis.**

I. INTRODUCTION

The condition that road infrastructure is burdened by traffic volume with heavy burden repeatedly will cause a decrease in the quality of the road. As an indicator, it can be seen from the condition of the damaged road surface, both in terms of structural and functional conditions.

The existing condition of Muara Teweh-Puruk Cahu road section with ± 100 km long is mostly uphill and bends. The road section is currently experiencing significant damage, both minor and severe damage, on several roads and almost along the road section. This road damage disrupts the traffic, both heading to PurukCahu and vice versa.

This study aims to determine the type of road damage on MuaraTeweh-PurukCahu road section and to analyze the correlation between damage and vehicle speed on roads with flat and hilly terrain. The benefit of this research is to provide findings obtained from the results of evaluation and analysis that will later be used as input to the relevant technical agencies, so that the damage repair can be conducted optimally and efficiently.

II. LITERATURE REVIEW

2.1 Inter-City Road Geometry

Classification of road terrain for geometric planning can be seen in the following table:

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Table 2.1 Classification based on Road Terrain

No.	Types of Terrain	Notation	Medan Slope (%)
1.	Flat	D	< 3
2.	Hilly	B	3 – 25
3.	Mountain	G	>25

Source: Geometric Planning Procedures for Inter-City Roads, Ministry of Public Works, Director General of BinaMarga (1997)

2.2 Criteria of Road Flexibility Pavement

In order to provide a sense of security and comfort to road users, road pavement construction must meet the traffic and strength/structural requirements.

2.3 Analysis of Road Performance

Pavement performance of a road section must be able to provide safe and comfortable services according to the plan for the road durability. The pavement evaluation will record the characteristics that can describe the performance of the pavement through several indexes. Based on the characteristics that have been surveyed, pavement evaluation can be classified into functional evaluation and structural evaluation (Christopher Bennett, 2007).

Based on MKJI 1997, the parameters of road performance include the volume and the speed of vehicle.

2.4 Road Damage

Road damage is one of the parameters to determine the performance of a road section. Damage on the pavement can be seen from the condition of functional and structural damage. Functional damage occurs when the pavement cannot function as what has planned. Meanwhile, structural damage can be seen by damage of one or more parts of the road pavement structure. Functional failure occurs when the pavement no longer functions as what has been planned and causes discomfort for road users. Meanwhile, structural failure is characterized by damage of one or more parts of the road pavement structure due to unstable subsoil, traffic loads, surface fatigue, and environmental conditions (Yoder, 1975).

One of the ways to find out the type of road damage is by looking at the classification of road damage (BinaMarga) according to the Road Maintenance Manual Number 03/MN/B/1983 issued by the Directorate General of BinaMarga.

2.5 Statistics Testing

2.5.1 Regression

Analysis with regression method has two variables, namely dependent variable (Y) and independent variable (X) which have the basic form Y = f (X). Modeling may be influenced by more than one independent variable and the possibility of a large number of independent variables that can affect the program together or separately.

2.5.2 Correlation

Correlation test is used to determine whether a variable has a correlation or affects a problem or other variables.

2.5.3 T –Test

This test is intended to test the independent variable (regression coefficient) whether it has an influence on the dependent variable.

2.5.4 F –Test

Testing on the distribution of F or F-test is intended to determine whether the variables that predict the formation of regression meet the requirements seen from a significant value at a certain level of confidence. This significant value is gained by comparing the calculated F value with F value of the table with a certain level of confidence. Said to be significant if the calculated F value is greater than the table F value.

III. RESEARCH METHOD

3.1 Steps of Data Collection

There are 2 (two) types of data that will be used for analyzing this study, namely:

a. Secondary Data

Secondary data is data that already exists. In this study, the sources of data can be obtained from relevant agencies. The types of data needed to support this study are administrative boundary maps, road network maps, and road status.

b. Primary Data

Primary data is a source of research data obtained by conducting direct observations in the field (surveys) including traffic volume data, road damage data, vehicle speed data, and road geometric data.

c. Instruments

The instruments used in this study are in the form of a daily survey form, speed gun, stopwatch, stationery, and other supporting tools related to this study.

d. Procedure of Data Collection

The data needed in this study can be grouped into three data groups, namely traffic volume data, average speed data, and road damage data.

3.2 Data Analysis Technique

Based on the data collected, the techniques of data analysis applied in this study are:

a. Analysis of the type of road damage using the BinaMarga method, namely by calculating the

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speed of LV, HV vehicles passing through the road in good condition, and damage on flat and hilly terrain;

b. Analysis of the correlation between vehicle speed and road damage through statistical tests with SPSS 20 (Statitistical Program for Social Science) software.

IV. RESULT AND DISCUSSION

4.1 Analysis of Traffic Volume

The traffic data used is LHR data obtained based on a survey conducted for 2 (two) days, Saturday and Sunday, with the duration for survey of 12 hours. The distribution of survey observations on vehicles is grouped into three groups, namely:

a. Light Vehicles, which are all four-wheeled motorized vehicles, include sedans (private cars), public transportation, mini bus, pick-up/boxes, and mini trucks.

b. Heavy Vehicle, i.e. all four-wheeled motorized vehicles, including large buses, 2-axle trucks, 3-axle trucks, trailers, and trailer trucks

c. Motorcycle

Survey data can be seen in the following table 4.1

Table 4.1 The Average Number of Vehicle

Day	Types of Vehicle			Total	
	HV	LV	MC	Vehicle	PCU
Saturday	22	65	53	140	173
Sunday	30	73	67	170	215
				Average	194

4.2 Analysis of Road Damage

Data is grouped based on topography or type of road terrain, namely flat and hilly, as seen in table 2.1 in Chapter II. Based on the survey results, the extent and percentage of comparison of the types of damage can be seen in table 4.2 below:

Table 4.2 Extent and Percentage of Comparison of the Types of Damage

No.	STA.	Types of Terrain	Length of Seg (m)	Width of Seg (m)	Seg. Area (m²)	Types of Road Damage							
						Cracks		Groove	Patches and potholes		Surface	Road Depression	
						Area (m²)	%	Inner (mm)	Area (m²)	%	Roughness	Area (m²)	%
1	90+800	F	100	5	500	1.02	0.21	-	-	-	R	-	-
2	90+400	F	100	5	500	0.63	0.13	30	104.67	20.93	D	10.00	2.00
3	90+200	F	75	5	375	1.21	0.32	20	22.12	5.90	D	-	-
4	89+500	F	50	4.5	225	0.07	0.03	-	1.25	0.56	D	56.00	24.89
5	87+600	F	100	5	500	5.60	1.12	-	-	-	-	10.50	2.1
6	85+500	H	75	5	375	18.39	4.90	-	-	-	-	54.53	14.54
7	85+165	H	50	5	250	0.24	0.10	22	-	-	-	10.25	4.10
8	76+700	H	100	6	450	-	-	-	-	-	R	120.00	26.67
9	74+600	H	75	6	450	20.53	4.56	-	-	-	R	14.40	3.20
10	71+600	H	50	6	300	-	-	-	0.35	0.12	-	71.20	23.73
11	70+650	H	50	6	300	2.30	0.77	-	-	-	R	-	-
12	67+700	H	50	6	300	-	-	-	-	-	-	81.80	27.27
13	62+300	H	100	6	600	8.76	1.46	20	241.89	40.32	-	10.08	1.68
14	40+200	H	100	4.5	450	18.30	4.07	25	35.74	7.94	R	24.07	5.35

Based on the table 4.2, it can be seen that in Sta. 89 + 500, damage occurs with the largest percentage of roads with flat terrain, namely road depression with a percentage of 24.89% of the road segment area. As for the road on the hilly terrain, at Sta. 67 + 700, damage occurs with the largest percentage in the form of depression of 27.27% of the road segment area.

Cracks, with the largest percentage on roads with flat terrain, occur at Sta. 87 + 600, that is equal to 1.12%, and on roads with hilly terrain occurs at Sta. 40 + 200, that is 4.07%.

Types of damage in the form of patches and potholes with the largest percentage on roads with flat terrain occurs at Sta. 90 + 400, that is equal to 20.93%,

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and on roads with hilly terrain occurs at Sta. 62 + 300, that is equal to 40.32%.

4.3 Vehicle Speed

Based on the local speed survey (spot speed) on roads with flat terrain, it is known that the minimum speed of light vehicle (LV) occurs at Sta. 90 + 400 of 12.59 km/hour with the types of damage that occur are cracks, grooves, potholes, and depression. Based on the calculation of the local speed (spot speed) of heavy vehicles on roads with flat terrain is the minimum speed of heavy vehicles (HV) occurs at Sta. 90 + 400 of 13.14 km/hour with the types of damage that occur are cracks, grooves, potholes, and depression.

Based on the local speed survey (spot speed) when the light vehicle goes uphill, it is seen that the minimum speed of light vehicles (LV) occurs at Sta. 85 + 500 of 18.11 km/hour with the types of damage are cracks and depression. Meanwhile, when light vehicle goes downhill, the minimum speed of light vehicles (LV) occurs at Sta. 74 + 600 at 11.73 km/hour with the types of damage are cracks and depression. Based on the local speed survey (spot speed), the minimum speed at which a heavy vehicle (HV) goes uphill occurs at Sta. 40 + 200 of 14.52 km/hour with the types of damage are cracks, grooves, potholes, and depression. Meanwhile, when heavy vehicle goes downhill, the minimum speed heavy vehicles (HV) occurs at Sta. 85 + 500 of 15.46 km/hour with the types of damage are cracks and depression.

Based on the explanation above, the road performance, in this case is the speed of the vehicle, is affected by road damage, where the dominant ones occur are cracks, grooves, potholes, and depression. Therefore, a statistical test is needed to determine the correlation between the dominant road damage and vehicle speed.

4.4 Analyzing Data using Statistic Testing

Software used in this statistics test is SPSS (Statistical Program for Social Science) 20 for Windows.

The dependent variable is the speed of vehicle, while the independent variables selected based on the types of road damage according to the BinaMarga method are cracks, grooves, potholes, and depressions. The test aims to determine the correlation between independent variables and dependent variable. Based on the statistical test with SPSS 20, a model with the following criteria is chosen:

1. It is selected based on the value of the correlation coefficient (R) because this value can reveal how much the variation of the dependent variable that can be represented by the regression equation. F value is calculated, where F value at a certain level of confidence can show how much variation in the regression line equation that can be represented by the independent variables.
2. The value of t-count, where with the value of t can show how strong the influence of coefficient of the independent variable equation toward the regression line equation.
3. The results of the regression analysis are tested using classic assumption test, namely the normality regression test, the multicollinearity test, and the heteroscedasticity test.

The results of statistical tests of data for light vehicles (LV) and heavy vehicles (HV) with the types of damage on roads with flat and hilly terrain are as follows:

1. Type of damage and speed of light vehicles (LV) on a flat road
   Based on the statistics tests of Linear Regression using Stepwise method, the results are presented in the following table.

Table 4.3 The results of regression testing for the dependent variable (y) and the independent variable (x) LV in the flat terrain

No.	Dependent Variables (y)	Independent Variables (x)	R	Coefficients, t(Sig.)	ANOVA, F(Sig.)
1	Speed	Groove area (x2)	0.558	-4.847(0,000)	23.498(0,000)
2	Speed	Groove area (x2) Depression area (x4)	0.720	-5.910(0,000) -4.675(0,000)	27.392(0,000)
3	Speed	Groove area (x2) Depression area (x4) Cracked area (x1)	0.816	-7.516(0,000) -5.367(0,000) -4.708(0,000)	33.227(0,000)

Based on the table above, it can be seen that the correlation value in Model 3 shows a very strong correlation, so it can be interpreted that the speed of LV on a flat road is affected by road damage with the type of damage in the form of cracks, groove, and depression.

The ANOVA table from SPSS 20 test shows the calculated F value = 33.227 and Sig. 0.000 <0.05. Based on the table, the value of F table = 2.790 because F count > F table, meaning that there is a linear correlation in the linear regression model between the independent variable and the dependent variable. Coefficients table from SPSS 20 test shows t-count > t table = 2.009 and Sig. <0.05, meaning that, partially, there is a significant influence between the independent variable (x1, x2, x4) and the dependent variables (y).

Regression normality test shows the histogram graph that the curve line is normal (mean≈0) and the graph of normal probability plots shows that the points tend to approach diagonal lines, so it can be said as normally distributed. Statistic normality regression test One Sample Kolmogorov Smirnov D count <D table or 0.062 <0.185, Z count <Z table or 0.454 <1.96 (95%) and the significance value (Asymp. Sig. 2-tailed) of 0.986> 0.05, then the residual value has been normal. In the multicollinearity test, the correlation table shows the entire correlation coefficient (R) <R value of the model, so it can be concluded that there is no multicollinearity problem in the regression model.

Heteroscedasticity test can be done graphically and using Spearman's rho correlation coefficient test. Graphically, based on the results of the linear regression analysis plot, it can be seen that the points do not have pattern and spread above and below axis y (number 0). Thus, it can be concluded that there is no heteroscedasticity problem in the regression model. According to Spearman's rho Correlations table on the SPSS 20 results, it can be seen that the Sig. (2-tailed) Unstandardized Residual > 0.05. Thus, it can be concluded that there is no heteroscedasticity problem in the regression model.

1. Types of damage and speed of heavy vehicles (HV) on a flat road

Based on Linear Regression statistical test taken using the Stepwise method, the results are presented in the following table:

Table 4.4 The results of regression testing of the dependent variable (y) and the independent variable (x) HV on the flat field

No.	Dependent Variables (y)	Independent Variables (x)	R	Coefficients, t(Sig.)	ANOVA, F(Sig.)
1	Speed	Depression area (x4)	0.447	-3.603(0.001)	12.982(0.001)
2	Speed	Depression area (x4)	0.627	-4.245(0.000)	16.489(0.000)
		Groove area (x2)		-4.025(0.000)	
3	Speed	Depression area (x4)	0.779	-5.009(0.000)	25.721(0.000)
		Groove area (x2)		-5.509(0.000)	
		Crack area (x1)		-5.218(0.000)	
4	Speed	Depression area (x4)	0.801	-5.615(0.000)	21.967(0.000)
		Groove area (x2)		-5.125(0.000)	
		Crack area (x1)		-5.156(0.000)	
		Hole area (x3)		2.194(0.000)	

Based on the table above, it can be seen that the correlation value in Model 4 shows a very strong correlation, so it can be interpreted that the speed of HV on a flat road is affected by road damage with the type of damage in the form of cracks, grooves, depression, and potholes.

The ANOVA table from the SPSS 20 test shows the calculated F value = 21,967 and Sig. 0.000 <0.05. Based on the table, the value of F table = 2.561 because F count > F table, meaning that there is a linear correlation in the linear regression model between the independent variable and the independent variable. The Coefficients table of SPSS 20 test shows t count > t table = 2.010 and Sig. <0.05, meaning that, partially, there is a significant influence between the independent variable (x1, x2, x4) and the dependent variable (y).

Regression normality test shows the histogram graph that the curve line is normal (mean≈0) and the graph of normal probability plots shows that the points tend to approach diagonal lines, so it can be said as normally distributed. Statistic regression normality test of One Sample Kolmogorov Smirnov D count < D table or 0.131 < 0.185, Z count < Z table or 0.961 < 1.96 (95%) and the significance value (Asymp. Sig. 2-tailed) of 0.314> 0.05, then the residual value has been normal. In the multicollinearity test, the correlations table shows the entire correlation coefficient (R) <Rvalue of the model. Thus, it can be concluded that there is no multicollinearity problem in the regression model.

Heteroscedasticity test can be done graphically and Spearman's rho correlation coefficient test. Graphically, from the results of the linear regression analysis plot it can be seen that the points do not have pattern and spread

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above and below the axis y (number 0). Thus, it can be concluded that there is no heteroscedasticity problem in the regression model. Based on Spearman's Correlations rho table on the SPSS 20 results, it can be seen that the Sig. (2-tailed) Unstandardized Residual > 0.05, meaning that there is no heteroscedasticity problem in the regression model.

2. Type of damage and speed of light vehicles (LV) uphill on the road in the hilly terrain

Based on the Linear Regression statistical test taken using the Stepwise method, the results are presented in the following table.

Table 4.5 Regression test results on the dependent variable (y) and the independent variable (x) of LV when going uphill

No.	Dependent Variables (y)	Independent Variables (x)	R	Coefficients, t(Sig.)	ANOVA, F(Sig.)
1	Speed	Crack area (x1)	0.440	-3.978(0.000)	15.827(0.000)
2	Speed	Crack area (x1)	0.705	-6.466(0.000)	32.196(0.000)
		Depression are (x4)		-6.274(0.000)	
3	Speed	Crack area (x1)	0.771	-7.636(0.000)	31.272(0.000)
		Depression are (x4)		-7.786(0.000)	
		Groove area (x2)		-3.909(0.000)	
4	Speed	Crack area (x1)	0.788	-7.941(0.000)	25.789(0.000)
		Depression are (x4)		-8.077(0,000)	
		Groove area (x2)		-4.019(0,000)	
		Pothole area (x3)		2.093(0,040)	

Based on the table above, it can be seen that the correlation value in Model 4 shows a very strong relationship. Thus, it can be interpreted that the speed of LV when going uphill the hilly roads is affected by road damage with the type of damage in the form of cracks, grooves, depressions, and potholes.

The ANOVA table from the SPSS 20 test shows the calculated F value = 25.789 and Sig. 0.000 < 0.05. Based on the table, the value of F table = 2.518 because F count > F table, meaning that there is a linear correlation in the linear regression model between the independent variable and the dependent variable. Coefficient table from the SPSS 20 test shows t-count > t table = 1.998 and Sig. <0.05, meaning that, partially, there is a significant influence between the independent variables (x1, x2, x3 and x4) and the dependent variable (y).

Regression normality test shows the histogram graph that the curve line is normal (mean≈0) and the graph of normal probability plots shows that the points tend to approach diagonal lines, so it can be said as normally distributed. Statistical normality regression test of One Sample Kolmogorov Smirnov D count < D table or 0.072 < 0.165, Z count < Z table or 0.594 < 1.96 (95%) and the significance value (Asymp. Sig. 2-tailed) of 0.873> 0.05, then the residual value has been normal. In the multicollinearity test, the Correlations table shows the entire correlation coefficient (R) <Rvalue of the model. Thus, it can be concluded that there is no multicollinearity problem in the regression model.

Heteroscedasticity test can be done graphically using Spearman's rho correlation coefficient test. Graphically, based on the results of the linear regression analysis plot, it can be seen that the points do not have pattern and spread above and below the axis y (number 0). Thus, it can be concluded that there is no heteroscedasticity problem in the regression model. Based on Spearman's Correlations rho table on the SPSS 20 results, it can be seen that the Sig. (2-tailed) Unstandardized Residual > 0.05, meaning that there is no heteroscedasticity problem in the regression model.

3. Types of damage and speed of light vehicles (LV) when going downhill the hilly terrain

Based on Linear Regression statistical test taken using the Stepwise method, the results are presented in the following table:

Table 4.6 Results of regression testing of the dependent variable (y) and the independent variable (x) of LV going downhill

No.	Dependent Variables (y)	Independent Variables (x)	R	Coefficients, t(Sig.)	ANOVA, F(Sig.)
1	Speed	Depression area (x4)	0.487	-4.465(0.000)	19.935(0.000)
2	Speed	Depression area (x4) Crack area (x1)	0.716	-6.851(0.000) -5.965(0.000)	33.142(0.000)
3	Speed	Depression area (x4) Crack area (x1) Groove area (x2)	0.741	-7.418(0.000) -6,382(0,000) -2,250(0,000)	25.207(0.000)

Based on the table above, it can be seen that the correlation value in Model 3 shows a strong correlation, so it can be interpreted that the speed of LV when going downhill the hilly road is influenced by road damage with the types of damage in the form of cracks, grooves, and depressions.

The ANOVA table from the SPSS 20 test shows the calculated F value = 33.227 and Sig. 0.000 <0.05. Based on the table, the value of F table = 2.753 because F count > F table, meaning that there is a linear correlation in the linear regression model between the independent variable and the dependent variable. Coefficients table from the SPSS 20 test shows t count > t table = 1.999 and Sig. <0.05, meaning that, partially, there is a significant influence between the independent variable (x1, x2, x4) and the dependent variable (y).

Regression normality test shows the histogram graph that the curve line is normal (mean≈0) and the graph of normal probability plots shows that the points tend to approach diagonal lines, so it can be said as normally distributed. Statistic regression normality test One Sample Kolmogorov Smirnov shows D count < D table or 0.108 <0.167, Z count < Z table or 0.880 < 1.96 (95%) and the significance value (Asymp. Sig. 2-tailed) is 0.421> 0.05, then the residual value has been normal. In the multicollinearity test, the Correlation table shows the entire correlation coefficient (R) <Rvalue of the model, meaning that there is no multicollinearity problem in the regression model.

Heteroscedasticity test can be done graphically using Spearman's rho correlation coefficient test. Graphically, based on the results of the linear regression analysis plot, it can be seen that the points do not have pattern and spread above and below the axis y (number 0). Thus, it can be concluded that there is no heteroscedasticity problem in the regression model. Based on Spearman's Correlations rho table on the SPSS 20 results, it can be seen that the Sig. (2-tailed) Unstandardized Residual > 0.05, meaning that there is no heteroscedasticity problem in the regression model.

4. Type of damage and speed of heavy vehicles (HV) going uphill on the road with hilly terrain

Based on Linear Regression statistical test taken using the Stepwise method, the results are presented in the following table:

Table 4.7 Regression test results on the dependent variable (y) and the independent variable (x) HV when going uphill

No.	Dependent Variables (y)	Independent Variables (x)	R	Coefficients, t(Sig.)	ANOVA, F(Sig.)
1	Speed	Crack area (x1)	0.485	-4.466(0.000)	19.949(0.000)
2	Speed	Crack area (x1) Depression area (x4)	0.750	-7.366(0.000) -6.928(0.000)	41.182(0.000)
3	Speed	Crack area (x1) Depression area (x4) Groove area (x2)	0.800	-8.472(0.000) -8.348(0.000) -3.694(0.000)	37.429(0.000)
4	Speed	Crack area (x1) Depression area (x4) Groove area (x2) Pothole area (x3)	0.816	-6.693(0.000) -8.509(0.000) -3.815(0.000) -2.135(0.037)	30.796(0.000)

Based on the table above, it can be seen that the correlation value in Model 4 shows a very strong corelation, so that it can be interpreted that the speed of HV when going uphill on a hilly road is affected by road damage with the type of damage in the form of cracks, grooves, potholes, and depression.

The ANOVA table from the SPSS 20 test shows the calculated F value = 30.796 and Sig. 0.000 <0.05. Based on the table, the value of F table = 2.520 because F

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count > F table, meaning that there is a linear correlation in the linear regression model between the independent variable and the dependent variable. Coefficient table from the SPSS 20 test shows t count > t table = 1.998 and Sig. <0.05, meaning that, partially, there is a significant influence between the independent variables (x1, x2, x3 and x4) and the dependent variable (y).

Regression normality test shows the histogram graph that the curve line is normal (mean≈0) and the graph of normal probability plots shows that the points tend to approach diagonal lines, so it can be said as normally distributed. Statistical normality regression test One Sample Kolmogorov Smirnov shows D count <D table or 0.105 < 0.166, Z count <Z table or 0.861 < 1.96 (95%) and the significance value (Asymp. Sig. 2-tailed) is 0.449 > 0.05, then the residual value has been normal. In the multicollinearity test, the Correlation table shows the entire correlation coefficient (R) <Rvalue of the model, meaning that there is no multicollinearity problem in the regression model.

Heteroscedasticity test can be done graphically using Spearman's rho correlation coefficient test. Graphically, based on the results of the linear regression analysis plot, it can be seen that the points are patternless and spread above and below the axis y (number 0). Thus, it can be concluded that there is no heteroscedasticity problem in the regression model. Based on Spearman’s Correlations rho table on the SPSS 20 results, it can be seen that the Sig. (2-tailed) Unstandardized Residual > 0.05, meaning that there is no heteroscedasticity problem in the regression model.

5. Type of damage and the speed of heavy vehicles (HV) going uphill on the road with hilly terrain

Based on the Linear Regression statistical test taken using the Stepwise method, the results are presented in the following table:

Table 4.8 Results of regression tests for the dependent variable (y) and the independent variable (x) HV when going downhill the slope.

No.	Dependent variables (y)	Independent Variables (x)	R	Coefficients, t(Sig.)	ANOVA, F(Sig.)
1	Speed	Depression area (x4)	0.550	-5.274(0.000)	27.816(0.000)
2	Speed	Depression area (x4) Crack area (x1)	0.699	-7.110(0.000) -4.788(0.000)	30.133(0.000)
3	Speed	Depression area (x4) Crack area (x1) Groove area (x2)	0.723	-7.589(0.000) -5.133(0.000) -2.093(0.000)	22.627(0.000)

Based on the table above, it can be seen that the correlation value in Model 3 shows a strong correlation, so it can be interpreted that the speed of HV when going downhill the hilly roads is affected by road damage with the types of damage in the form of cracks, grooves, and depression.

The ANOVA table from the SPSS 20 test shows the calculated F value = 22,627 and Sig. 0.000 < 0.05. Based on the table, the value of F table = 2.753 because F count > F table, meaning that there is a linear correlation in the linear regression model between the independent variable and the dependent variable. Coefficients table from the SPSS 20 test shows tcount > t table = 1.999 and Sig. < 0.05, meaning that, partially, there is a significant influence between the independent variable (x1, x2, x4) and the dependent variable (y).

Regression normality test shows the histogram graph that the curve line is normal (mean≈0) and the graph of normal probability plots shows that the points tend to approach diagonal lines, so it can be said as normally distributed. Statistical normality regression test One Sample Kolmogorov Smirnov shows D count < D table or 0.064 < 0.167, Z count < Z table or 0.523 < 1.96 (95%) and the significance value (Asymp. Sig. 2-tailed) is 0.947> 0 .05, then the residual value has been normal.

In the multicollinearity test, the Correlations table shows the entire correlation coefficient (R) <Rvalue of the model, meaning that there is no multicollinearity problem in the regression model.

Heteroscedasticity test can be done graphically using Spearman's rho correlation coefficient test. Graphically, based on the results of the linear regression analysis plot, it can be seen that the points do not have pattern and spread above and below the axis y (number 0). Thus, it can be concluded that there is no heteroscedasticity problem in the regression model. Based on Spearman’s Correlations rho table on the SPSS 20 results, it can be seen that the Sig. (2-tailed) Unstandardized Residual > 0.05, meaning that there is no heteroscedasticity problem in the regression model.

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V. CONCLUSION

Based on the analysis and discussion of the data presented in the previous chapter, it can be concluded that:

1. The types of damage that occur at MuaraTeweh - PurukCahu road section based on the classification of BinaMarga method are cracks, grooves, patches, potholes, surface roughness and depression.
2. The speed of light vehicles and heavy vehicles that tends to decrease when passing through MuaraTeweh - PurukCahu road section is more dominantly affected by the types of damage, namely cracks, grooves, potholes, and depression.
3. The speed of light vehicles on roads with flat terrain shows a very strong correlation with the type of damage, namely cracks, grooves, and depression. The speed of light vehicle when going uphill shows a very strong correlation with the type of damage, namely cracks, grooves, patches, and depression. Meanwhile, the speed of vehicle when going downhill shows a strong correlation with the types of damage, namely cracks, grooves, and depression.
4. The speed of heavy vehicles on roads with flat terrain shows a very strong correlation with the types of damage, namely cracks, grooves, potholes, and depression. The speed of heavy vehicle when going uphill shows a very strong correlation with the types of damage, namely cracks, grooves, potholes, and depression. Meanwhile, the speed of vehicle when going downhill shows a strong correlation with the types of damage, namely cracks, grooves, and depression.

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