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The Relationship between the Factors That Cause Road Damage and Its Effect on Road Damage In the City Of Palangka Raya

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Abstract: *The road pavement failure effect much problems for the city such traffic accident, side effect of transportation, more failure if the problems did not solve effectively. There are several factors that cause the road failure such as water, traffic problems, climate, the material of road pavement, subgrade condition, and the process of compaction. The environmental factors like as climate also effect the road pavement failure. The aims of this research is to analyze the relationship among the cause factors that effectthe road pavement failure especially for road on peatland.The research site is Palangka Raya City, Central Kalimantan Province, Indonesia.*

The result showed that there is significant relationship between the factors that cause road damage and its effect on road damage in the city of Palangka Raya for road on peatland This relationship refer to this equation is $Y= -2.78335 + 0.358X_1 + 0.549X_2 + 0.635X_3 + 0,.675X_4 + 1.142\ X_5 + 0.709\ X_6$ *where Y is the road pavement failure for road on peatland and X are the factors which effected the road pavement failure. If the value of X increase so the value of Y is bigger than before.*

Keywords: *peatland, infiltration, climate, fibrous peat.*

I. Introduction

Palangka Raya City is the capital of Central Kalimantan Province. It is one of the province in Kalimantan Island, Indonesia. The road in this city has 607,741 km2 length (Department of Public Works City of Palangka Raya, 2010) . Several road is built on peatland because the route of the traffic of passenger and goods must followed the locations. The conditions are good and very good about 49.7%and the road conditions are poor and very poor about 50.3%.

Several factors can cause the road damages. According to Sukirman (1995) the factor that cause the damages are water, the traffic, climate, the material of road construction, subgrade condition and the process of compaction. The visual observation showed that the road damages has a relationship with the cause factors.

Based on preliminary studies it is known that the land base at the study site is peat soil. Peat is a type of soft soil with high content of fibrous organic matters and can be defines as an accumulation of 100% pure organic material contains less than 35% mineral or at least 65% organic content. (Muhamad et al, 2010). The content of peat is different based on the location of study (Huat, 2004) depend on temperature, climate and humidity also the origin fibre. Peat has its unique characteristic make it pose its own distinctive properties different with the inorganic soils that made up by the soils particles (Deboucha et al, 2008).

Deposits of peat are found when the conditions are favorable for their accumulation and formation (Asadi et al, 2009). Huat (2004) stated that peat deposits is distributed extensively at many countries of the world. The peatland covers about 5 to 8% of the land of earth surface and covers about 60% of the wetlands. The amount of tropical peatland is about 30 millions hectares and two third of 30 millions hectares are in South East Asia. The amount of peat in Indonesia is about 26 million hectares, in Japan is about 2,000km2, in Malaysia is approximately 3 millions hectares contained of 6,300 hectares is in Pontian, Batu Pahat and Muar in West Johore (Yulindasari, 2006) and 1.66 million hectares in Sarawak (Said and Taib, 2009). Peat can be found in Canada, Russia and in US, the total of peat is 30 million hectares (Mesri and Aljouni, 2007).

Peat can be slassified based on several criteria. One of the classification is based on their ash and organic content (ASTM, 1990). Tropical peat like as in Peninsular Malaysia has the ash content is about 3.55 and organic content is about 96.45%,. It means that the peat is very high of organic matter and the lose of ignition value about 90% (Islam and Hashim, 2008a,b). The texture of peat is dependent of the type of peat. The fibrous peat is coarse and clay is smooth related to the particle size and behavior of compressibility (Gofar, 2006). Generally, peat is high water content because of peat has low bulk density and bearing capacity due to its

high buoyancy and pore volume. According to Aljouni (2000), Aljouni and Mesri (2009) peat has the water content about 200 to 2000% and In West Malaysia, Huat (2004) stated that the water content about 200-700%. The unit weight of fibrous peat in Peninsular Malaysia is about 8.3 to 11.5 kN/m^3 (Huat, 2004). The unit weight of this soil affected by its water content that if the water content increase so the unit weight decrease such as if water content about 500% so the unit weight is about 10 to 13 kN/m3 (Kazemian et al, 2009a). Peat also has the coefficient of permeability that expressed the velocity and Darcy's law to determine the flow of water through fibrous peat (Wong, 2005;Wong et al, 2008). At a given void ratio, the vertical coefficient of permeability is lower than the horizontal coefficient of permeability that indicates the horizontal coefficient of consolidation of peat is greater than the vertical coefficient of consolidation (Gofar, 2006). The acidity is one of chemical characteristic of peat that usually tested in several studies. The acidity of peat is decreasing with depth and the decrease may be large near the bottom layer depend on the kind of underlying soil (Aljouni, 2000;Kazemian et al, 2009a,b,c,d,e; Kazemian et al, 2010 a,b). Generally, pH of peat is about 4 to 7 and the peat have hugh cation exchange capacity (CEC). The CEC of fibrous peat is larger than amorphous peat (Moayedi et al, 2011a,b).

The aim of this research is to analyze the relationship between the dependent variable (road pavement failure) and the independent variable (the factors that cause the road damages/failure) for road on peatland.

II. Study Method

Study Site

The research site is Palangka Raya City, Central Kalimantan Province Indonesia. It was done at September-October 2015.

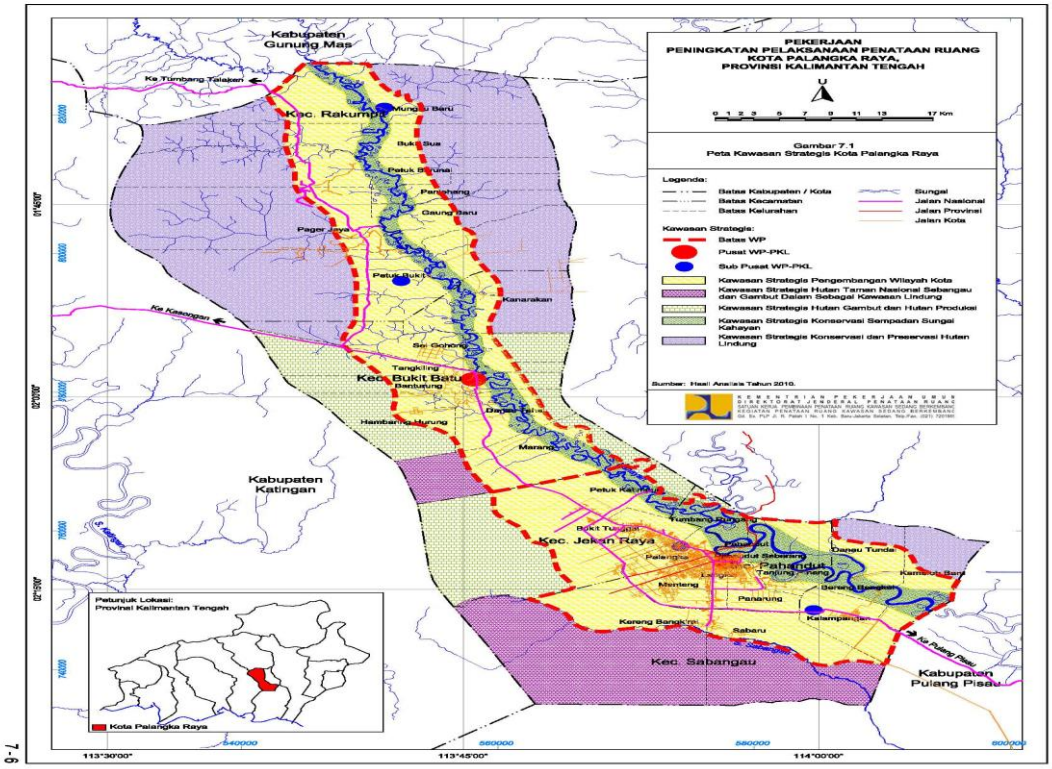

Figure 1.1 Map of Palangka Raya(Department Of Civil Work, 2010)

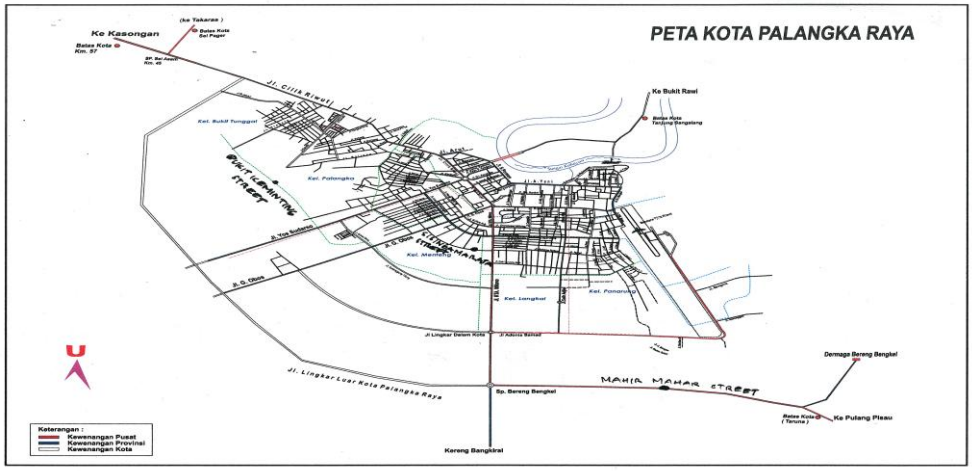

Figure 1.2 Map of Road in Palangka Raya City (Department Of Civil Work, 2010)

Study Approach

This study used the explanatory research method to explain the causal relationship between the road pavement failure and the cause factors.

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Population and Sample

Population

In this research the population is the expert of road project or everyone that has knowledge and experience in road engineering in Central Kalimantan.

Sample

According to Widayat (2004) the sample of research is about 30 to 500. So the sample is determined about 121 persons. The collecting sample technique used accidental sampling.

The method of collecting data are questionnaire, interview and documentation.

Operational Definition of Variable and The Measurement of the Variable

Operational Definition of Variable

The variables in this research are dependent and independent variables. The dependent Variable (Y) is the road pavement failure and the independent variables (X) are X_1, X_2, X_3, X_4, X_5, X_6. The indicators for Y are cracks, distorsion, disintegration, polished aggregates, bleeding or flushing, utility cut depression. The indicators for X_1 (Infiltration of rainwater, drainage system is not good, water rising due to the nature of capillarity), X_2 (increase in load, repeated load), X_3 (an increase in air temperature, high rainfall- water flooded the road), X_4(material quality standards that are less well, material processing system that is not good), X_5(basic soil properties is not good, system implementation is not good), X_6(soil compaction process that is not well.

The Measurement of variable

The questions or statement in the questionnaire is the closed question with 5 options of the answers such as very significant, significant, enough significant, not significant, very insignificant. Likert scale is used to measure the variable, the scale are 5 (very significant), 4 (significant), 3 (enough significant), 2 (not significant), 1 (very insignificant).

III. Methode of Data Analysis

Validity and Reliability Test

The data that collecting from questionnaires is the primary data that must be processed and analyzed using The Program *SPSS for windows*.

Validity Test

This test used SPSS Program for Windows based on Analysis of Product Moment that count the correlation coefficient among the score items with the total score.

$$r = \frac{n(\sum xy) - (\sum y)}{\sqrt{n(\sum x^2) - (\sum x)^2}.\sqrt{n(\sum y^2) - (\sum y)^2}}$$ (Sudjana, 2010) ……(1.1)

where:

r = correlation coefficient among the items with the total score
x = score of the answer for each item
y = total score
n = amount of sample

Reliability Test

Testing reliability of the instrument in this study is done by comparing the Cronbach Alpha coefficients were calculated using the computer program SPSS for Windows. Alpha formula to determine the reliability of the instrument are: $r_{11} = \frac{k}{k-1}\left[1 - \frac{\sum \sigma b^2}{\sigma_1^2}\right]$ (Sudjana, 2010)……(1.2)

where r_{11} = Instrument of Reliability
k = the number of questions
σb^2 = the number of varians
$\sigma 1^2$ = Total varians

Multiple Regression Analysis

The analysis of the effect among two independent variables or more against the dependent variable can be used the Multiple Regression Analysis. The equation is:

$Y = a + b_1X_1 + b_2X_2 + \ldots\ldots + b_nX_n$ (Sugiyono, 2012) …….(1.3)

where:

Y = The dependent variable
X = The independent variable
a = constanta Of regression
b = coefisient of regression

Data Analysis

Table 1.1 Frequency Distribution of Variable X_1

Item	Very Significant		Significant		Significant Enough		Less Significant		Very Insignificant		Total	
	F	%	F	%	F	%	F	%	F	%	F	%
X1.1	29	24,0	53	43,8	31	25,6	2	8,0	0	0.0	121	100
X1.2	32	26,4	48	39,7	33	27,3	8	6,6	0	0.0	121	100
X1.3	39	32,2	33	27,3	41	33,9	8	6,6	0	0.0	121	100

Source: Primary data processing (2015)

From the results of questionnaires known to respondents' opinions about the first item of the variable Air (X_1) which is about the infiltration of rainwater in mind as much as 53 respondents, or 43.8% expressed significant, as many as 31 respondents, or 25.6% stated enough, as many as 29 respondents or 24% of the total respondents stated very significant and as many as 8 respondents or 6.6% of the total respondents expressed less. With a mean value of 3.85 indicates if the respondent according to the infiltration of rain water has a significant effect on road pavement damage on peat.

For road drainage system is not good as much as 48 respondents, or 39.7% of the total respondents stated significant, as many as 33 respondents, or 27.3% of the total respondents stated enough, as many as 32 respondents, or 26.4% of the total respondents expressed a very significant and as many as 8 or 6.6% of respondents expressed less. With a mean value of 3.86 indicates if the road drainage system according to respondents who either do not have a significant effect on road pavement damage on peat.

For items rising waters due to the nature of capillarity as many as 41 respondents, or 33.9% of the total respondents stated enough, as many as 39 respondents, or 32.2% of the total respondents stated very significant, as many as 33 respondents, or 27.3% of the total respondents expressed significant and as much as 8 respondents or 6.6% of the total respondents expressed less. With a mean value of 3.85 indicates if the respondent by rising water due to capillarity properties have a significant effect on road pavement damage on peat.

Table 1.2 Frequency Distribution of Variable X_2

Item	Very Significant		Significant		Significant Enough		Less Significant		Very Insignificant		Total	
	F	%	F	%	F	%	F	%	F	%	F	%
X2.1	27	22,3	45	37,2	38	31,4	11	9,1	0	0.0	121	100
X2.2	26	21,5	33	27,3	45	37,2	17	14,0	0	0.0	121	100

Source: Primary data processing (2015)

From the results of questionnaires known to respondents' opinions about the first item of the variable Traffic (X_2), namely the increase of load is known by 45 respondents or 37.2% expressed significant, as many as 38 respondents, or 31.4% stated enough, as many as 27 respondents, or 22.3% of the total respondents stated very significant and as many as 11 respondents or 9.1% of the total respondents expressed less. With a mean value of 3.73 indicates if the load increases according to respondents have a significant effect on road pavement damage on peat.

To reps load on the road as much as 45 respondents, or 37.2% of the total respondents stated enough, as many as 33 respondents, or 27.3% of the total respondents stated significant, as many as 26 respondents, or 21.5% of the total respondents stated very significant and as many as 17 or 14.0% of respondents expressed less. With a mean value of 3.56 indicates if the respondent according to the reps have a significant effect on road pavement damage on peat.

Table 1.3 Distribusi Frekuensi Variabel X_3

Item	Very Significant		Significant		Significant Enough		Less Significant		Very Insignificant		Total	
	F	%	F	%	F	%	F	%	F	%	F	%
X3.1	48	39,7	39	32,2	30	24,8	4	3,3	0	0.0	121	100
X3.2	41	33,9	46	38,0	23	19,0	11	9,1	0	0.0	121	100

Source: Primary data processing (2015)

From the results of questionnaires known to respondents' opinions about the first item of the variable climate (X_3) that the air temperature increases (heat) is known as much as 48 respondents, or 39.7% stated very significant, as many as 39 respondents, or 32.2% expressed significant, as many as 30 respondents, or 24.8% of the total respondents stated enough and as much as 4 respondents or 3.3% of the total respondents expressed less. With a mean value of 4.08 indicates if the respondent according to the air temperature increases (hot) has a significant effect on road pavement damage on peat.

For high rainfall (water flooded the street) as many as 46 respondents, or 38.0% of the total respondents stated significant, as many as 41 respondents, or 33.9% of the total respondents stated very significant, as many as 23 respondents, or 19.0% of total respondents stated enough and as many as 11 respondents or 9.1% said less. With a mean value of 3.97 indicates if the respondent according to the high rainfall (water flooded the road) has a significant effect on road pavement damage on peat.

Table 1.4 Distribusi Frekuensi Variabel X_4

Item	Very Significant		Significant		Significant Enough		Less Significant		Very Insignificant		Total	
	F	%	F	%	F	%	F	%	F	%	F	%
X4.1	12	9,9	61	50,4	42	34,7	6	5,0	0	0.0	121	100
X4.2	17	14,0	45	37,2	55	45,5	4	3,3	0	0.0	121	100

Source: Primary data processing (2015)

From the results of questionnaires known to respondents' opinions about the first item of variables Construction Materials Pavement (X_4), namely the quality standard of materials that are less well known as many as 61 respondents or 50.74 declared significant, as many as 42 respondents, or 34.7% stated enough, as many as 12 respondents or 9.9% of the total respondents stated very significant and as much as 6 respondents or 5.0% of the total respondents expressed less. With a mean value of 3.65 indicates if the respondent according to quality standards that are less good material has a significant effect on road pavement damage on peat.

For material processing system that is not good by 55 respondents, or 45.5% of the total respondents stated enough, as many as 45 respondents, or 37.2% of the total respondents stated significant, as many as 17 respondents, or 14.0% of the total respondents stated enough and as much 4 respondents or 3.3% said less. With

a mean value of 3.62 indicates if the material processing system according to respondents who either do not have a significant effect on road pavement damage on peat.

Table 1.5 Distribusi Frekuensi Variabel X_5

Item	Very Significant		Significant		Significant Enough		Less Significant		Very Insignificant		Total	
	F	%	F	%	F	%	F	%	F	%	F	%
X5.1	11	9,1	55	45,5	45	37,2	10	8,3	0	0.0	121	100
X5.2	6	5,0	63	52,1	49	40,5	3	2,5	0	0.0	121	100

Source: Primary data processing (2015)

From the results of questionnaires known to respondents' opinions about the first item of the variable Land Condition Basic (X_5) is about the nature of the land base that is not well known by 55 respondents or 45.5% expressed significant, as many as 45 respondents, or 37.2% stated enough, as many as 11 respondents or 9.1 % of the total respondents stated very significant and as many as 10 respondents or 8.3% of the total respondents expressed less. With a mean value of 4.55 indicates if the respondent according to the basic soil properties is not good to have a significant effect on road pavement damage on peat.

For the implementation of the system is not good as much as 46 respondents, or 38.0% of the total respondents stated significant, as many as 63 respondents, or 52.1% of the total respondents stated significant, as many as 49 respondents, or 40.5% of the total respondents stated enough and as much as 6 or 5.0% of respondents expressed a very significant and as high as 3 respondents or 2.5% of the total respondents expressed less. With a mean value of 3.60 indicates if the implementation of the system according to the respondents who either do not have a significant effect on road pavement damage on peat.

From the results of questionnaires known to respondents' opinions about the variables Process Compaction (X6) is the process of soil compaction that is not well known as many as 40 respondents, or 33.1% stated enough, as many as 36 respondents, or 29.8% expressed significant, as many as 25 respondents, or 20.7% of the total respondents stated very significant and as many as 20 respondents, or 16.5% of the total respondents expressed less. With a mean value of 3.55 indicates if the soil compaction process according to respondents who either do not have a significant effect on road pavement damage on peat.

IV. Result Of Validity Test

Table 1.6 Validity Testing Results (X_1)

Item	The value of r	r table	Sig	Description
$X_{1.1}$	0,841	0,176	0,000	Valid
$X_{1.2}$	0,753	0,176	0,000	Valid
$X_{1.3}$	0,765	0,176	0,000	Valid
$X_{2.1}$	0,852	0,176	0,000	Valid
$X_{2.2}$	0,873	0,176	0,000	Valid
$X_{3.1}$	0,850	0,176	0,000	Valid
$X_{3.2}$	0,872	0,176	0,000	Valid
$X_{4.1}$	0,804	0,176	0,000	Valid
$X_{4.2}$	0,826	0,176	0,000	Valid
$X_{5.1}$	0,879	0,176	0,000	Valid
$X_{5.2}$	0,809	0,176	0,000	Valid
Y_1	0,828	0,176	0,000	Valid
Y_2	0,784	0,176	0,000	Valid
Y_3	0,821	0,176	0,000	Valid
Y_4	0,818	0,176	0,007	Valid
Y_5	0,787	0,176	0,000	Valid
Y_6	0,826	0,176	0,000	Valid

Source: Primary data processing (2015)

Based on this test the result is every variables can be used for the research because they are valid.

Table 1.7 Result of Realibilty Test

No.	Variable	Alpha Cronbach	Description
1.	X_1	0,820	Reliable
2.	X_2	0,873	Reliable
3.	X_3	0,872	Reliable
4.	X_4	0,843	Reliable
5.	X_5	0,861	Reliable
6.	Y	0,801	Reliable

Source: Primary data processing (2015)

According to calculation can be conclude that the instrument of research is reliable.

V. Result of Classical Assumption Test

a. The Result of Heteroskedastisitas Test

Scatter Plot of Heteroskedastisitas Test

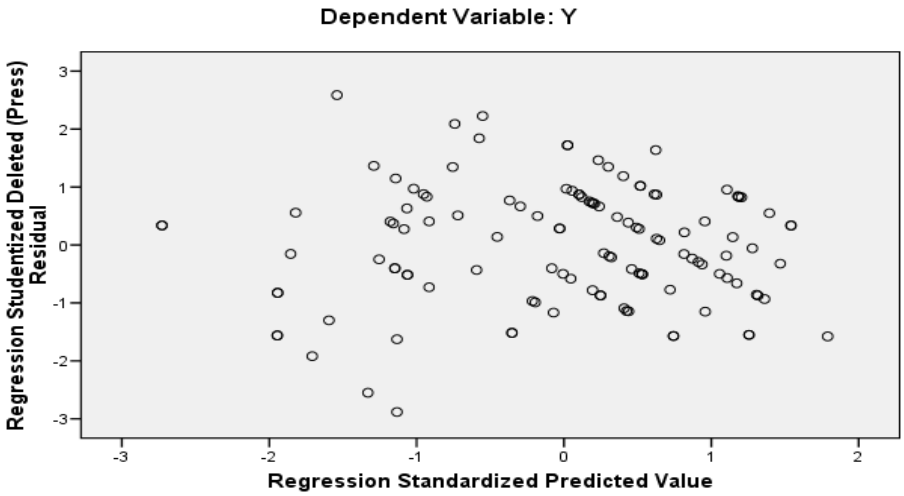

Figure 1.3 Scatter Plot of Heteroskedastisitas Test

Based on the graphic that there is not an heteroskedastisitas to regression model.

b. Test results Multicolinearity

Table 1.8 The Result of Multicolinearity Assumption Test

Independent Variable	VIF	Description
X_1	1.539	Non Multikolinear
X_2	1.282	Non Multikolinear
X_3	1.236	Non Multikolinear
X_4	1.286	Non Multikolinear
X_5	1.688	Non Multikolinear
X_6	1.781	Non Multikolinear

Source: Primary data processing (2015)

Based on the calculation show that every variables has the value of VHF no more than 10.

c. Result of Normality Test

The graphic of P-P Plot is shown in Figure 1.4

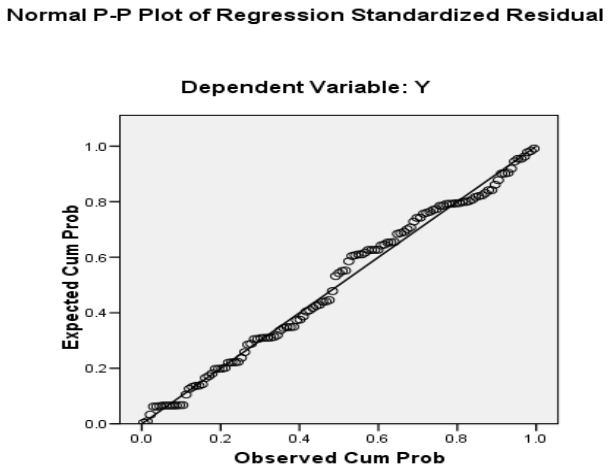

Figure 1.4 Normal P-P Plot of Regression Standardized Residual

The standardized residual value make a linear pattern that indicate the residual value has normal distribution.

Result of Analysis

Table 1.9 Result of Multiple Regression Analysis

No	Variable	Coefficient of Regression	t-count	Sig
1.	X_1	0.358	2.494	0.014
2.	X_2	0.549	3.219	0.002
3.	X_3	0.635	3.652	0.000
4.	X_4	0.675	2.944	0.004
5.	X_5	1.142	4.241	0.000
6.	X_6	0.709	2.157	0.033

Source: Primary data processing (2015)

constanta	=	-5.480
R	=	0.819
R Square	=	0.670
Fcount	=	38.658
Sig	=	0.000

1. The coefficient of correlation (R) show the level of the relationship among the independent variables (X) simultaneously against the dependent variable (Y).. Value of R which is obtained from the analysis is 0.819 showed that the variables X (X_1,X_2, X_3, X_4 dan X_5) ssimultaneously have a very strong relationship with Y.

Table 1.10 Interpretation of Correlation Coefficient (r)

Interval Coefficient	Relationship Level (Interpretation)
0,00-0,199	Very low
0,20-0,399	Low
0,40-0,599	Enough
0,60-0,799	Strong
0,80-1,00	Very Strong

2. The value of R Square shows the contribution (contribution) independent variables were examined simultaneously on the dependent variable. The results of analysis R square value of 0.670 indicates if the independent variables (X1, X2, X3, X4, X5 and X6) simultaneously affect the dependent variable (Y) of 67.0% for the remaining 33.0% is influenced by other variables not examined in this study.
3. F Test
   F count indicates whether all independent variables (X) studied simultaneously have a significant influence on the dependent variable (Y).
4. t test
   From t test can conclude that all independent variables has the significant effect to dependent variable (Y).
   Regression Equation :
   $Y = -5.480 + 0.358\ X_1 + 0.549\ X_2 + 0.635\ X_3 + 0.675\ X_4 + 1.142\ X_5 + 0.709\ X_6$
   The explanation of the equation are:
   a. Constanta about -5.480 show that if no effect of the independent variables so the dependent variable has the constant value about -5.480.
   b. Coefisient of regression X1 (b1) about 0.358 show that there is an positive effect between variable X1 against the variable Y, it mean that the higher the value of X1, the higher the value of Y.
   c. Coefisient of regression X2 (b2) about 0.549 show that there is an positive effect between variable X2 against the variable Y, it mean that the higher the value of X2, the higher the value of Y.
   d. Coefisient of regression X3 (b3) 0.635 show that there is an positive effect between variable X3 against the variable Y, it mean that the higher the value of X3, the higher the value of Y.
   e. Coefisient of regression X4 (b4) 0.675 show that there is an positive effect between variable X4 against the variable Y, it mean that the higher the value of X4, the higher the value of Y.
   f. Coeffisient of regression X5 (b5) 1.142 show that there is an positive effect between variable X5 against the variable Y, it mean that the higher the value of X5, the higher the value of Y.
   g. Coeffisient of regression X6 (b6) 0.709 show that there is an positive effect between variable X6 against the variable Y, it mean that the higher the value of X6, the higher the value of Y.

VI. Conclusion

There is a significant relationship among the factor that cause the road pavement failure following the equation: $Y = -5.480 + 0.358\ X_1 + 0.549\ X_2 + 0.635\ X_3 + 0.675\ X_4 + 1.142\ X_5 + 0.709\ X_6$. Coeffisient of regression X5 (b5) 1.142 is greater than others it means that soil condition of peatland has more effect to road pavement damage.

Suggestion

It is important to know well the key of suitable maintenance for the road on peatland based on the the cause of failure to prevent more failure in the road pavement. Beside that it need a comprehensive design of the road refer to the cause of failure to anticipate the failure or damage of the road on peatland in Palangka Raya City.

References

[1] Aljouni, MA.(2000) *Geotechnical Properties of Peat and Related Engineering Problems.* PhD Dissertation, University of Illnois at Urbana-Champaign.

[2] Asadi, A., Huat, B., Hanafi, M., Mohamed, T., Shariatmadari, N, (2009) *Role of Organic Matter on Electroosmotic Properties and Ionic Modification of Organic Soils*, Geocsci. J., 13(2):175-181.

[3] Deboucha S, Hashim R, Alwi A. (2008) *Engineering Properties of Stabilized Tropical Peat Soils*. J. Geotech. Eng. 13E: 1-9.

[4] Department of Civil Works City of Palangka Raya. (2010) *Data of The Street in Palangka Raya City.*

[5] Islam MS, Hashim R. (2008a) *Use of Macintosh Probe Test for Field Investigation in Peat Soil*. Proceeding of The International Conference, May 26-27, Best Western Premier Seti Pacific Kuala Lumpur, Malaysia, pp 27.

[6] Islam S, Hashim R. (2008b) *Engineering Properties of Peat Soils In Peninsular Malaysia*. J. Appl. Sci., 8(22).

[7] Gofar, N (2006) *Determination of Coefficient of Rate of Horizontal Consolidation of Peat Soil.* Master Dissertation, Universiti Teknologi Malaysia, Malaysia

[8] Gofar, Nurly and Sutejo, Yulindasari. (2007) *Long Term Compression Behavior of Fibrous Peat.* Malaysian Journal of Civil Engineering, 19 (2). Pp. 104-116. ISSN 1823-7843.

[9] Huat, BBK. (2004) *Organic and Peat Soils Engineering*. University Putra Malaysia Press Serdang, Malaysia.

[10] Kazemian S, Huat BBK. (2009a) *Compressibility Characteristic of Fibrous Tropical Peat Reinforced with Cement Column*, Electronic J. Geotech. Eng., 14E:1-8.

[11] Kazemian S, Asadi A, Huat BBK. (2009c) *Laboratory Study On Geotechnical Properties of Tropical Peat Soils*, Int. J. Geotechnics Environ., 1:69-79.

[12] Kazemian S, Prasad A, Huat BBK, Ali TAM, Aznieta FN. (2010a) *Effect of cement, Sodium Silicate, Kaolinite and Water on The Viscosity of The Grout*, Sci. Res. Essay J., 5(22): 3434-3442.

[13] Mesri G, Aljouni M. (2007) *Engineering Properties of Fibrous Peat*. J. Geotech. Geoenviron. Eng., 133(7): 850-866.

[14] Moayedi H, Asadi A, Huat BBK, Moayedi F. (2011a) *Zeta Potential of Tropical Soil in Presence of Polyvinyl Alcohol*, Int. J. ElectrochemSci., 6(5): 1294-1306.

[15] Moayedi H, Asadi A, Huat BBK, Moayedi F. (2011b) *Optimizing Stabilizers Enhanced Electrokinetic Environment to Improve Physicochemical Properties of Highly Organic Soil*, Int. J. ElectrochemSci., 6(5): 1277-1293.

[16] Muhamad IS, Gandaseca S, Ahmed OH, Majid NMA. (2010) *Comparison of Selected Chemical Properties of Peat Swamp Soil Before and After Timber Harvesting.* Am. J. Environ. Sci., 6 (2).

[17] Said JM, Taib SNL(2009) *Peat Stabilization with Carbide Lime*. UNIMAS E-J. Civil Eng. 1:1.

[18] Sudjana,(1996) *Teknik Analisis Regresi dan Korelasi.* Tarsito. Bandung.

[19] Sugiyono, (2012) *Metode Penelitian Kuantitatif Kualitatif dan R & B* Alfabeta. Bandung.

[20] Sukirman, S.(1995) *Perkerasan Lentur Jalan Raya*, Nova, Bandung.

[21] Widayat (2004) *Aplikasi Software SPSS.* Universitas Muhammadiyah Malang. Malang.

[22] Wong, Leong Sing (2005) *Laboratory Evaluation of Horizontal Coefficient of Consolidation Cc of Fibrous Peat Soil,* Master Dissertation, Universiti Teknologi Malaysia.

[23] Wong LS, Hashim R, Ali FH. (2008) *Strength and Permeability of Stabilized Peat* Soil. J. Appl. Sci, 8(17):1-5.

[24] Wong, Leong Sing., Hashim Roslan., Ali, Faisal Haji (2008) *Compression Rates of Untreated and Stabilized Peat Soils*, EJGE Volume 13, Bund. F.

[25] Yulindasari I. (2006) *Compressibilty Characteristic of Fibrous Peat Soil*. Master Disstertation, Universiti Teknologi Malaysia, Malaysia