pavement evaluation

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PAVEMENT EVALUATION OF MARGOREJO ROAD KARANGMALANG DISTRICT SRAGEN REGENCY BASED ON DYNAMIC CONE PENETROMETER TEST

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ABSTRACT

Margorejo road, Karangmalang district is one of the roads that has status as a district road in Sragen regency. The condition of the pavement on Margorejo road is bad, with the traffic volume and load of vehicles passing Margorejo road can be said as low, because it is only 228.8 vehicles/hour. In the next few years, a sports building will be established which will increase the volume and load of vehicles passing Margorejo road. This study is intended to evaluate the pavement of Margorejo road in serving the flow of vehicles both for the present and for the future. The existing pavement of Margorejo road will be evaluated based on Pt T-01-2002-B Bina Marga. This evaluation caried out using field CBR data with a DCP test, The existing surface course of Margorejo road is a 10 cm reinforced concrete, it needs 11,85 cm after the evaluation. Therefore, it is necessary to re-plan or increase Margorejo road pavement layer. With a small vehicle load, the author's hypothesis about the cause of the damage to the pavement of Margorejo road is the poor composition of the layer. Without a base and a subbase course, thus soft particles from the subgrade course will go up to surface course, which will quickly reduce the life and strength of the pavement structure. In addition, the poor drainage in Margorejo road is also one of the causes.

KEYWORDS: *Pavement Layer, Margorejo, CBR.*

INTRODUCTION

The road is a land transportation infrastructure that covers all parts of the road, including road building which is intended for traffic that is at, above or below the surface of the land or water and above the water level, except railroads, lorry roads, and cable roads. According to Hendarsin (2000), the existance of the highway is very necessary to support the rate of economic growth along with the increasing need for transportation facilites that can reach coutrysides.

The needs of road insfrastructure Sragen's people are also increasing every year, it is based on economic, social, political and cultural developments in the community. Margorejo road, Karangmalang district is one of the roads that has status as a district road in Sragen regency. A huge number vehicles passes contribute a road damage (Kusumawardani, 2018; Nugroho, 2017; Kusumawardani, 2017). The condition of the pavement on Margorejo road is bad, with the traffic volume and load of vehicles passing Margorejo road can be said as low, because it is only 228.8 vehicle/hour. This article was written to analize the factors that caused the damage to the pavement of Margorejo road and the pavement thickness needs for current traffic flow.

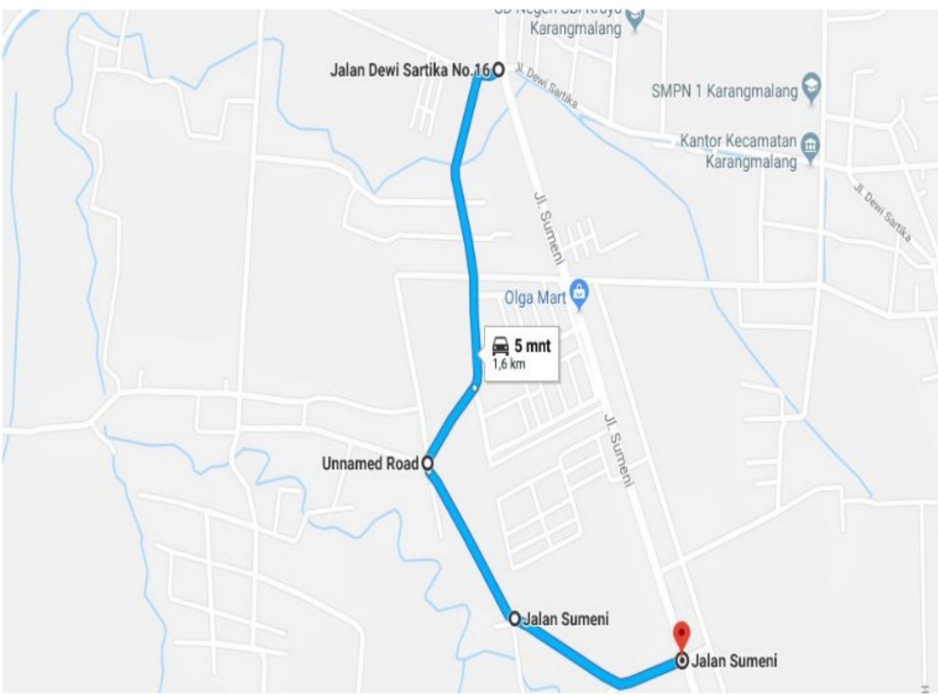

Figure 1: Margorejo Road Location.

METHOD OF RESEARCH

1. Basic Planning

In this article the evaluation of Margorejo road pavement refers to The Indonesian Guidelines of Flexible Pavement Thickness Design Pt T 01-2002-B (Direktorat Jenderal Bina Marga, 2002) by using Component Analysis Method (Deaprtemen Pekerjaan Umum, 1987), The Indonesian Guidelines of Flexible Pavement Thickness Design No.002-P-BM-2011 (Direktorat Jenderal Bina Marga, 2011), and The Dynamic Cone Penetrometer test refers to ASTM International (2003) D6591 – 03 Standard Test Method for Use of the Dynamic Cone Penetrometer in Shallow Pavement Applications. This methods explain about The Guidelines Standard Operation Procedure of California Bearing Ratio Testing (CBR) and Dynamic Cone Penetrometer (DCP) Testing.

2. Resilient Modulus (M_R)

According to The Guidelines of Flexible Pavement Thickness Design Pt T-01-2002-B (Direktoral Jenderal Bina Marga, 2002), the strength and durability of the pavement are very dependent on the properties and carrying capacity of the soil. Resilient Modulus is the subgrade parameter used in pavement planning. This following correlation between resilient modulus and CBR values can be used for fine grained soil with the soaked CBR value <10.

M_R(psi) = 1500 x CBR ………………………………………………………… (1)

3. Vehicle Axle Load Equivalent Number (E)

"Vehicle Axle Load Equivalent Number (E) is a number that shows the number of trajectories of a single axis weighing 8.16 tons which will cause the same damage or the same decrease of surface index if the standard axle load pass one time." (Tenriajeng, 2002)

Whereas according to Hendarsin (2000) are:

E single axis $= \left(\frac{\text{single axle load single axis in kg}}{8160}\right)^4$ ………………………..……..… (2)

E double axis = $\left(\frac{\text{single axle load double axis in kg}}{8160}\right)^4 \times 0{,}816$ ……………....…….… (3)

4. Cumulative Standard Single Axle Load (W_t)

Traffic in the plan lane (w18) is given in cumulative standard axle loads. According to Pt T-01-2002-B (2002) traffic in the plan lane can be obtained using the formula:

w18 = Vehicle/day x E ……………..………………………………….. (4)

w18/day = D_D x D_L x ŵ18 ……………………………….……………………. (5)

w18/year = w18/day x 365 ....…………………….…………………….. (6)

Where,

D_D = direction distribution factor.

D_L = lane distribution factor.

ŵ18 = cumulative standard axle load.

Meanwhile, according to Pt T-01-2002-B (2002) the formula used to calculate the number of cumulative standard single axle load is :

Wt = w18 x $\frac{(1+g)^n-1}{g}$ ……………………………………………………………….. (7)

Where,

g = traffic growth (%)

n = age of plan (year)

5. Reliability (R)

According to Pt T-01-2002-B, (2002) "The concept of reliability is an effort to incorporate the degree of certainty into the planning process to ensure various alternative plans will last for the life of the plan".

6. Design Serviceability Loss (ΔPSI)

ΔPSI = IP_o - IP_t ……………………………………………………………….... (8)

According to Hendarsin (2000) to determine IP at the end of the plan's age, it is necessary to consider the functional classification factors of the road as in Table 1. below:

Table 1: Surface Index at the End of Plan's Age (IPt).

Road Classification				LER
Local	Collector	Arteries	Tol	
1,0 – 1,5	1,5	1,5 – 2,0	-	<10
1,5	1,5 – 2,0	2,0	-	10-100
1,5 – 2,0	2,0	2,0 – 2,5	-	100-1000
-	2,0 – 2,5	2,5	2,5	>1000

According to Pt T-01-2002-B, (2002) to determine IP at the of the plan's age, it is necessary to consider the type of pavement's layer as in Table 2. below:

Table 2: Surface Index at the Start of Plan's Age (IP_0) (The Indonesian Guidelines of Flexible Pavement Thickness Design Pt T-01-2002-B,2002).

Types of Pavement	IP_0	IRI (ruggedness indexing) (m/km)
L A S T O N	≥ 4	$\leq 1{,}0$
	$3{,}9 - 3{,}5$	$> 1{,}0$
LASBUTAG	$3{,}9 - 3{,}5$	$\leq 2{,}0$
	$3{,}4 - 3{,}0$	$> 2{,}0$
L A P E N	$3{,}4 - 3{,}0$	$\leq 3{,}0$
	$2{,}9 - 2{,}5$	$> 3{,}0$

7. Layer Thickness *(D)*

- $D_1 = \frac{SN_1}{a_1}$ .... (9)

With a is a coefficient of relative strength.

RESULTS AND DISCUSSION

1. Existing Road Data

a. Existing Pavement Data

The existing pavement on Margorejo road consists of a surface layer in the form of 10 cm plain concrete, and the subgrade course below. The existing pavement of Margorejo road from STA 0 + 000 to STA 0 + 800 has a lot of damage, whereas starting from STA 0 + 800 to STA 1 + 586 the conditions of pavement are not feasible because it is still soil and concrete roads. The existing pavement layer arrangement of Margorejo road can be seen in Figure 2 below:

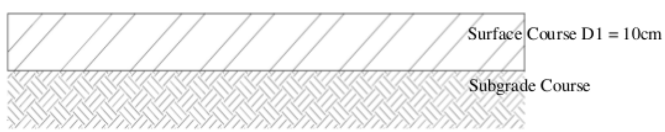

Figure 2: The existing pavement layer arrangement.

One of the factors that causes damage to Margorejo road's pavement is it doesn't have a base and subbase layer. Without a base and subbase layer, fine particles from the subgrade course will rise to the surface course, and the ground water will gather on the surface course, which will quickly reduce the life and strength of the pavement structure. The existing pavement data of Margorejo road can be seen in Table 3. below :

Table 3: The Existing Pavement of Margorejo Road.

STA	Pavement Type	Pavement Condition	Pavement Wide
0+000 - 0+050	Concrete	Vertical Cracking	3,1 m
0+050 - 0+100	Concrete	Crocodile Skin Cracking	
0+100 - 0+150	Concrete	Vertical Cracking	
0+150 - 0+200	Concrete	Vertical Cracking	
0+200 - 0+250	Concrete	Crocodile Skin Cracking	
0+250 - 0+300	Concrete	Good	3 m
0+300 - 0+350	Concrete	Vertical Cracking	3,05 m
0+350 - 0+400	Concrete	Vertical Cracking	
0+400 - 0+450	Concrete	Vertical Cracking	3 m
0+450 - 0+500	Concrete	Vertical Cracking	3,1 m
0+500 - 0+550	Concrete	Vertical Cracking	
0+550 - 0+600	Concrete	Vertical Cracking	3 m
0+600 - 0+650	Concrete	Vertical Cracking	
0+650 - 0+700	Concrete	Vertical Cracking	3,05 m
0+700 - 0+750	Concrete	Punch out	3,1 m
0+750 - 0+800	Concrete	Punch out	3,2 m
0+800 - 0+850	Soil and Concrete	Not Feasible	3,05 m
0+850 - 0+900	Soil and Concrete	Not Feasible	2,4 m
0+900 - 0+950	Soil and Concrete	Not Feasible	2,35 m
0+950 - 1+000	Soil and Concrete	Not Feasible	2,6 m
1+000 - 1+050	Soil and Concrete	Not Feasible	
1+050 - 1+100	Soil and Concrete	Not Feasible	
1+100 - 1+150	Soil and Concrete	Not Feasible	2,4 m
1+150 - 1+200	Soil and Concrete	Not Feasible	2,75 m
1+200 - 1+250	Soil and Concrete	Not Feasible	3,05 m
1+250 - 1+300	Soil and Concrete	Not Feasible	
1+300 - 1+350	Soil and Concrete	Not Feasible	2,95 m
1+350 - 1+400	Soil and Concrete	Not Feasible	2,3 m
1+400 - 1+450	Soil and Concrete	Not Feasible	3 m
1+450 - 1+500	Soil and Concrete	Not Feasible	3,1 m
1+500 - 1+550	Soil and Concrete	Not Feasible	2,9 m
1+550 - 1+586	Soil and Concrete	Not Feasible	3,3 m

(a) **(b)**

Figure 3. Vertical Cracking (a) and Crocodile Skin Cracking (b)

b. Existing Drainage Data

Margorejo road's drainage conditions are bad because not all area of the road already have a drainage, which means that water cannot flow to the disposal. Most of the Margorejo road's existing drainage is not a pure drainage, because it is only an irrigation channel with inadequate width.

The existing drainage conditions caused the water to hardly disappear from the pavement layer. With the pavement frequently affected by water, the quality of the pavement will decrease over time. Existing drainage data of Margorejo road can be seen in Table 4.

Table 4: Existing Drainage of Margorejo Road.

STA			Drainage		Information
			Left	Right	
0+000	-	0+100	-	-	-
0+100	-	0+200	-	-	-
0+200	-	0+300	Side Ditch	Side Ditch	concrete 30 cm wide, 15 cm depth
0+300	-	0+400	Side Ditch	Side Ditch	concrete 50 cm wide, 20 cm depth
0+400	-	0+500	Side Ditch	-	concrete 50 cm wide, 50 cm depth
0+500	-	0+600	-	-	-
0+600	-	0+700	-	-	-
0+700	-	0+800	-	-	-
0+800	-	0+900	Irrigation	irrigation	soil 30 cm wide, 30 cm depth
0+900	-	0+1000	Irrigation	irrigation	soil 30 cm wide, 30 cm depth
0+1000	-	0+1100	irrigation	Irrigation	soil 30 cm wide, 30 cm depth
0+1100	-	0+1200	Irrigation	-	soil 30 cm wide, 30 cm depth
0+1200	-	0+1300	-	-	-
0+1300	-	0+1400	irrigation	irrigation	soil 70 cm wide, 30 cm depth
0+1400	-	0+1500	-	-	-
0+1500	-	0+1586	Side Ditch	-	gravel 100 cm wide, 50 cm depth

2. Traffic Data

Peak traffic hour data for Margorejo Road is obtained by conducting traffic surveys for 40 consecutive hours which include weekdays and weekends. Peak hour traffic data is the highest traffic flow data from 40 hours of traffic data stated in pcu / hour. Peak traffic hour of Margorejo road is 228.8 vehicles / hour. Data of peak traffic hour on Margorejo road can be seen in figure below.

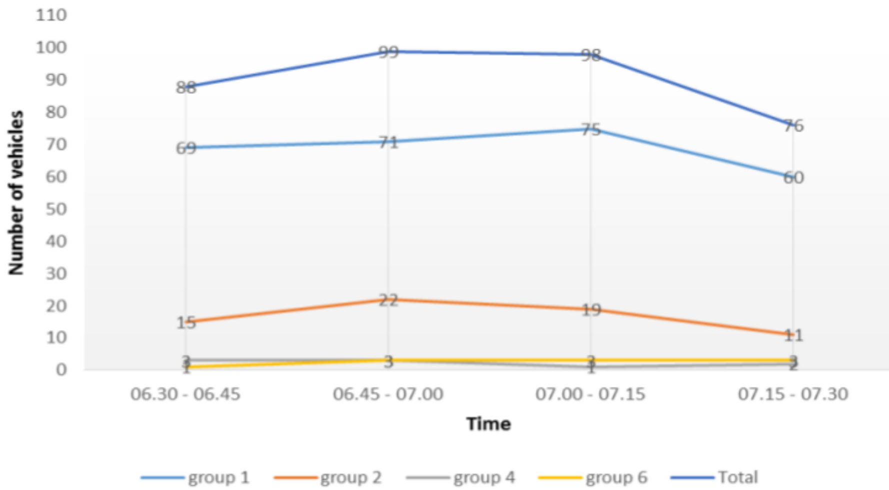

Figure 4: Peak Traffic Hour Chart.

3. *California Bearing Ratio (CBR)* Data

CBR value in this study were obtained by performing a dynamic cone penetrometer test using a dynamic cone penetrometer on Margorejo road by taking samples every 100 m using 30^o conus. Furthermore, the DCPT data will be used to find the 90% CBR value in which indicate that the value of 90% CBR is **9,73%.**

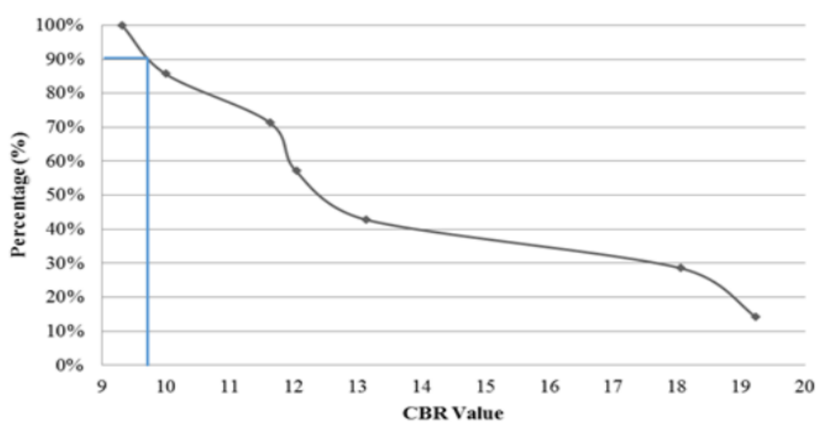

Figure 5: 90% CBR Value Chart.

CONCLUSIONS

1. From the results of observations and calculations of the need for pavement thickness, the thickness of the surface course required is 11.85 cm, while the thickness of the existing

surface layer is only 10 cm. Because of that, it is necessary to re-plan or increase Margorejo road pavement.

2. With a small vehicle load, the author's hypothesis about the cause of the damage to the pavement of Margorejo road is the poor composition of the layer. Without a base and a subbase course, thus soft particles from the subgrade course will go up to surface course, which will quickly reduce the life and strength of the pavement structure. In addition, the poor drainage in Margorejo road is also one of the causes.

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