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Flexible Road Pavement Thickness Planning using the 2017 Manual Road Pavement Design (MDPJ) Method and 1987 Component Analysis on the Jepara - Keling Road Section

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ABSTRACT

The increase in the volume of vehicles on the Jepara - Keling road has resulted in a decrease in the quality of road services, moreover, it has been exacerbated by the passing vehicles which often exceed their carrying capacity, thus accelerating road damage. Therefore, road planning efforts are needed to maintain road function from various potential damages that occur. The purpose of this thesis is to plan a flexible pavement thickness that is able to serve the volume of vehicles and withstand the loads of passing vehicles. Meanwhile, before planning a road, it is necessary to know the condition of the road, field CBR data, average daily traffic data and also need to plan what material the road will be built with. The approach method used in planning the thickness of the flexible pavement is using the 2017 Road Pavement Design Manual (MDPJ) method and the 1987 Component Analysis method. Based on the calculations that have been carried out, it is obtained that the thickness of the flexible pavement structure design is obtained for each layer using the Road Pavement Design Manual (MDPJ) method.) 2017 are as follows: for 4 cm thick AC-WC layer, 6 cm thick AC-BC layer, 16 cm thick AC-Base layer, and 30 cm thick Class A LPA layer. Whereas using the 1987 Component Analysis method, the thickness for each layer was obtained as Asphalt Concrete MS 740: 10 cm, Class A Crushed Stone LPB: 25 cm, Class A Sand and Stone LPB: 22 cm

Keywords: *Flexible Pavement; Daily Traffic; Axis load.*

INTRODUCTION

Highways are one of the infrastructures that fulfill very important needs in supporting human mobility and developing the economy. The greater the economic growth and mobilization, the greater the traffic volume and load on a vehicle[1]–[3]. This of course will have an impact on reducing the level of service quality on these roads. Pavement is a highway construction that plays a very important role in the smooth movement of vehicles[4], [5]. Technically, road pavement is a part of the road that is hardened with certain materials [6] and layers to increase certain strength, stability, thickness and stiffness so that the load of vehicles passing on the pavement can still be accepted by the subgrade and does not exceed the permitted carrying capacity of the soil so that the life of the road is long[7]. planned can be achieved. The goal to be achieved in this planning process is to obtain a flexible road pavement thickness design using the 2017 [8] Road Pavement Design Manual (MDPJ) method and the 1987 Component Analysis method to solve problems that occur in the field.

MATERIALS AND METHODS

The planning stage begins with collecting primary data and secondary data which will then be used in the planning process. Primary data is data obtained in the field, while secondary data is data obtained from related agencies and other relevant sources. The primary data obtained includes field CBR[9] value data obtained through field testing using the Dynamic Cone Penetrometer (DCP) [10], [11]test equipment. DCP testing is determined at 5 points along the planned road. After obtaining the DCP test data, it is then processed using a calculation process in such a way that the CBR value is obtained. Then the other primary data is average daily traffic data (LHR) [12], [13]which was obtained by conducting a vehicle volume survey for 7 days by selecting 3 time intervals for each day, namely during peak hours such as morning, afternoon and afternoon. The method used in planning the thickness of flexible pavement is to use 2 methods, namely:

1. 2017 Road Pavement Design Manual (MDPJ) [8] Method The stages in planning the thickness of flexible road pavement using the 2017 Road Pavement Design Manual (MDPJ) method are starting with determining the Design Age (UR) of the pavement, analyzing traffic volume in determining the planned LHR, determining traffic growth factors based on the 2017 MDPJ, determining direction distribution factor (DD) and lane distribution (DL), determining the Vahicle Damage Factor (VDF) value according to the vehicle class classification and calculating the total vehicle cumulative load or Cumulative Equivalent Single Axle (CESA), followed by determining the thickness of the pavement structure according to the provisions in MDPJ 2017, the final step is to check the condition of the basic soil whether it requires repair or not by referring to the CBR value of the field that has been carried out previously.
2. Component Analysis Method 1987 The stages in planning the thickness of flexible road pavement using the 1987 [14] Component Analysis method are starting with calculating traffic growth in the previous year with the LHR in the planning year, determining the LHR survey data that has been carried out as LHR0 data at the beginning of the pavement's life, then determining LHRA as the LHR at end of the planned life, determine the vehicle load equivalent figure (E), determine the vehicle distribution coefficient (C), calculate the initial equivalent traffic (LEP), calculate the final equivalent traffic (LEA), calculate the middle equivalent traffic (LET), calculate the planned equivalent traffic (LER), knowing the Soil Carrying Capacity (DDT) with previously obtained field CBR data, knowing the Regional Factor (FR) in the planned area, knowing the Surface Index at the end of the planning life (IPt) by referring to the LER value, knowing the Surface Index at initial design life (IPo) using the planned pavement material, obtain the Pavement Thickness Index (ITP) value using a nomogram, from the ITP value then plan the flexible pavement structure material with a minimum thickness for each layer.

RESULTS AND DISCUSSION

Based on the collection of primary data that has been done, the following data can be obtained:

Table 1. Field CBR data

Point	CBR (%)
1	1,78
2	1,69

3	1,73
4	1,80
5	1,84

Because the number of field CBR test points is less than 10 points, determining the segment CBR value can be determined by choosing the smallest CBR value, namely 1.69%.

Table 2. LHR data in 2023

No	Transportation type	LHR (Vehicles/day)
1.	Motorcycles, 3-Wheel Vehicles	6224
2.	Sedans, Jeeps, Station Wagons	279
3.	Moderate passenger transport	747
4.	Pick up, Micro truck, Delivery Car	363
5.	Small bus	25
6.	Big bus	9
7.	2 axle light truck	167
8.	2 axle medium truck	243
9.	3 axle truck	27
10.	Trailer truck	4
11.	Semi-trailer truck	6
12.	Non-motorized vehicles	6
	Total	8100

The data that has been obtained is thenprocessed using the 2017 Road Pavement Design Manual (MDPJ) method and the 1987 Component Analysis method. Based on the calculation and planning process that has been carried out, the following results are obtained :

1) 2017 Road Pavement Design Manual Method (MDPJ).

Table 3. 2017 MDPJ Method Calculation Results

No.	Planning Parameters	Planning Results
1	Plan Age	20 years
2	LHR in 2023 (for goals. 5b – 7c)	456
3	LHR construction period (for goals. 5b – 7c)	47
4	LHR service period (for goals. 5b – 7c)	907
5	Road Class	Collector
6	Segment CBR value	1,69%
7	Planning Location	Java Island
8	Traffic growth	3,5%
9	Directional Distribution Factor (DD) 2-way	0,5
10	Lane Distribution Factor (DL) 2 lanes	1
11	Cumulative growth multiplier (2023-2024)	1
12	Cumulative growth multiplier (2024-2043)	19,1

No.	Planning Parameters	Planning Results
13	Number of ESA 5 construction periods (2023-2024)	553.468
14	Number of ESA 5 construction periods (2023-2024)	21.034.524
15	CESA 5	21.587.991
16	Pavement Thickness: :	
	AC-WC	4 cm
	AC-BC	6 cm
	AC-Base	16 cm
	LPA Class A	30 cm

2) Component Analysis Methods 1987

Tabel 4. Hasil Perhitungan Metode Analisa Kompone 1987

No.	Planning Parameters	Planning Results
1	Plan Age	20 years
2	Road class	2 lane 2 way collector
3	Traffic growth	1,5%
4	LHR at the beginning of the planned life	8100
5	LHR end of planned life	10910
6	Vehicle distribution coefficient (C)	
	Light vehicle	0,5
	Heavy vehicle	0,5
7	Initial Equivalent Cross (LEP)	1084,869
8	Final Equivalent Cross (LEA)	1461,161
9	Middle Equivalent Cross (LET)	1273,015
10	Cross Equivalent Plan (LER)	2546,030
11	Segment CBR value	1,69%
12	Soil bearing capacity (DDT)	2,68
13	Percentage of heavy vehicles	25,7%
14	Rainfall data	284,618 mm/year
15	The slope of the road	2,73%
16	Regional Factor Value (FR)	0,5
17	Surface index at end of design life (IPt)	2,5
18	Surface index at the beginning of the design life (IPo)	≥4
19	Pavement thickness index (ITP)	13,8
20	Relative strength coefficient :	
	a1 : Laston MS 744 kg	0,40
	a2 : Laston MS 590 kg	0,28
	a3 : Sirtu/pitrun class A	0,13
21	Pavement Thickness :	
	Laston MS 744 kg	10 cm
	Laston MS 590 kg	25 cm
	Sirtu/pitrun kelas A	22 cm

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The flexible pavement thickness design uses the 2017 Pavement Design Manual (MDPJ) method:

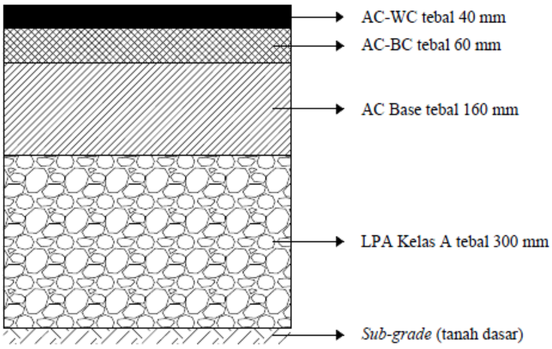

Figure 1. MDPJ 2017 flexible pavement design method

Flexible pavement thickness design using the 1987 Component Analysis method:

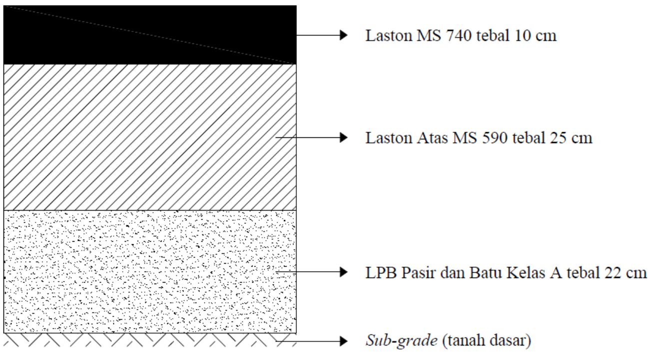

Figure 2. Flexible pavement design using the 1987 Component Analysis method

CONCLUSION

From the calculation of flexible pavement thickness planning using the 2017 Road Pavement Design Manual method and the 1987 Component Analysis method, the flexible pavement thickness design for each layer is obtained as below:

1. 2017 Road Pavement Design Manual Method
   AC-WC layer: 40 mm = 4 cm
   AC-BC layer: 60 mm = 6 cm
   AC Base layer: 160 mm = 16 cm
   LPA Class A : 300 mm = 30 cm
2. Component Analysis Method 1987
   MS 740 Asphalt Concrete Layer: 10 cm
   Class A Crushed Stone LPA: 25 cm
   Class A Sand and Stone LPB: 22 cm

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