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RIGID PAVEMENT DESIGN FOR THE JAWAR ROAD SURABAYA CITY WITH MANUAL DESIGN OF ROAD PAVEMENT 2017

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ABSTRACT
One type of highway pavement is currently being widely used in rigid pavement. Rigid pavement applied to the Jawar road Surabaya section, which connects the city of Surabaya and the city of Gresik, intended to improve the quality of roads in the West Surabaya industrial area, which is integrated with the North Gresik area and increases the economy's pace around the location. This planning uses the 2017 Road Pavement Design Manual Method with a focus on the thickness of the pavement. With a design life of 40 years and using a continuous pavement system with reinforcement, the capacity of this road is calculated based on the LHR survey carried out on this road segment, resulting in a vehicle load of 3.4 x 10^7*ESA5. Based on the results of the analysis, the pavement thickness was 29.5 cm with the addition of 10cm thin concrete and 15cm drainage layer, longitudinal reinforcement Ø12 – 200, transverse reinforcement Ø8 – 150, dowels Ø28 – 300, and tie bars Ø16 – 300.*

Keywords: *Rigid Pavement; Jawar Road; Manual Design of Road Pavement 2017.*

1. Introduction

The road is the most influential element[1] in everyday life, especially in mobilization or transportation[2]. The development of road construction in Indonesia has recently increased, with various improvements and the construction of new roads, making the flow of regional development[3] in Indonesia stable. A good road is a road that is feasible to pass as needed, meets quality standards, and has high durability[4]. With the highway, moving from place to place becomes easier, delivery of goods becomes easier, economic activity along with the road increases, and the safety factor when traveling becomes safe.

One of the road pavement methods used in Indonesia today is the rigid pavement type[5][6]. Since 1985, Indonesia has implemented rigid road pavement[7], which can also be called rigid pavement[8], in several cities. After this, the use of rigid pavement in road coating methods has been slow. However, the development of rigid pavements in Indonesia continues to overgrow for toll roads[7], national connecting roads, inter-provincial roads, and inter-city roads. For this reason, it is necessary to have more profound education in understanding the concepts, working methods, planning, implementation, and quality control of rigid pavement construction[9].

Therefore, Surabaya has also implemented this rigid pavement method on various roads to require pavement, considering the service load and extended design life required[10]. Jawar Street Surabaya is one of them, which is a connecting road from Gresik City to the Gelora Bung Tomo Stadium in Surabaya as a secondary collector road function. In contrast, the road class is class II, with a planned road width of 8 meters. Coinciding with the position of this road segment which is close to the GBT Surabaya Stadium area, consider it one of the roads that must be for its quality. Furthermore, the road position is due to the planning of Jalan Jawar Surabaya as an integrated road for the medium industrial sector of West Surabaya - North Gresik, increasing the pace of the regional economy and increasing regional income.

Surabaya City Government has severe intentions in planning and repairing Jalan Jawar Surabaya. Several focal points of the Surabaya City Government's work in repairing this road, including road widening, exfoliating old road materials, and road pavements. The hope of the Surabaya City Government regarding the improvement of Jalan Jawar Surabaya is that it can grow the economy of West Surabaya - North Gresik, highlight the area's contribution, and as an alternative to JLLB (West Outer Ring Road).

2. Methods

The following are the stages carried out by researchers in research:

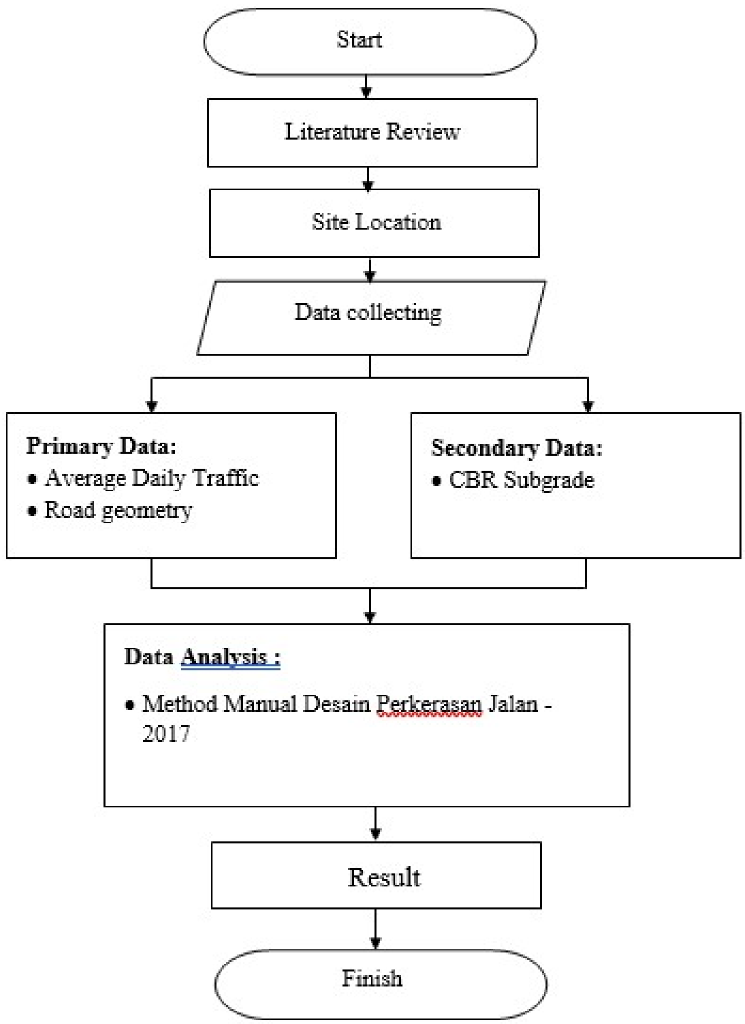

Figure 1. Step of Research

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2.1. Lokasi Penelitian

The location of the 2003 Pd T-14 method of rigid pavement research and the 2017 MDPJ method has been determined, which is on Jalan Jawar Surabaya, Benowo District, Surabaya City, East Java. The design length of rigid pavement is 800 m. Location map of Jalan Jawar Surabaya.

Figure 2. Research Location Map

2.2. Data Collecting

In this study, two data must be collected, namely primary and secondary data. These data were obtained from the relevant contractor as the planner of this rigid pavement for Jalan Jawar Surabaya.

a. Primary Data

The primary data in question is obtained directly from the field by researchers. This primary data is LHR (Average Daily Traffic) data which is very useful for calculating the planned road capacity.

LHR data is data on vehicles that pass on the road using a counting tool, commonly called a finger counter. The volume of vehicle calculation in the LHR survey is differentiated. According to the vehicle class that has been previously classified. The LHR data survey lasts for 1 day, 24 hours, with an interval of 15 minutes for volume recording.

b. Secondary Data

Secondary data in this study were obtained from research sources by parties related to the work planners for Jalan Jawar Surabaya rigid pavement, namely CV. Global Prisma Consulindo. This secondary data includes land data around the area of Jalan Jawar Surabaya.

2.3. Data Analysis

This rigid pavement method is guided by the Regulation of the Ministry of Public Works and Public Housing concerning Road Pavement Manual No 04/SE/Db/2017. There are several parameters to calculate rigid pavement thickness using the 2017 Road Pavement Design Manual method, namely:

a. CBR (California Bearing Ratio) is a parameter of the soil's ability to carry loads. Above the stated ground level. In CBR, value has units (%). One method usually used is the DCP (Dynamic Cone Penetration) test.
b. LHR data (Average Daily Traffic) is a survey in the context of data collection. The volume of the vehicle. Across a segment road. It has been planned. This survey was conducted for 1 day 24 hours by calculating the volume of passing vehicles. The calculation uses a counting tool called a finger counter according to a predetermined vehicle classification. From these

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data, it can be concluded that the average daily vehicle volume can also know at what time the densest vehicle volume can occur.

c. The life of the plan is determined based on the classification of road functions and composition. Traffic value is well known as the economic value of the road. Economic value can be determined using the Benefit-Cost Ratio method, Internal Rate of Return, or a combination of the two methods. The rigid road pavement plan is estimated to last 20 to 40 years.
d. Traffic Growth, traffic volume will increase with design age or until the stage when the growth factor reaches road capacity. Therefore, traffic can be determined by considering the design age and the percentage growth rate of traffic.

3. Result and Discussion

a. CBR Design Analisys

In planning the thickness of the pavement foundation layer, the CBR value of the subgrade is needed. This data is secondary data, which means it is obtained from the source or the data owner. Moreover, to determine the estimated thickness of the plate, this data must be processed again to obtain a 90% CBR.

Table 1. CBR Data for Subgrade

No.	CBR Value (Sorted)	Equal or Greater Value	Equal or Greater Percent (%)	Result (%)
1	5,67	13	13/13*100%	100
2	5,83	12	12/13*100%	92,31
3	5,83			
4	5,83			
5	6,17	9	9/13*100%	69,23
6	6,50	8	8/13*100%	61,54
7	6,50			
8	6,83	6	6/13*100%	46,15
9	7,17	5	5/13*100%	38,46
10	7,33	4	4/13*100%	30,77
11	7,67	3	3/13*100%	23,08
12	7,83	2	2/13*100%	15,38
13	8,67	1	1/13*100%	7,69

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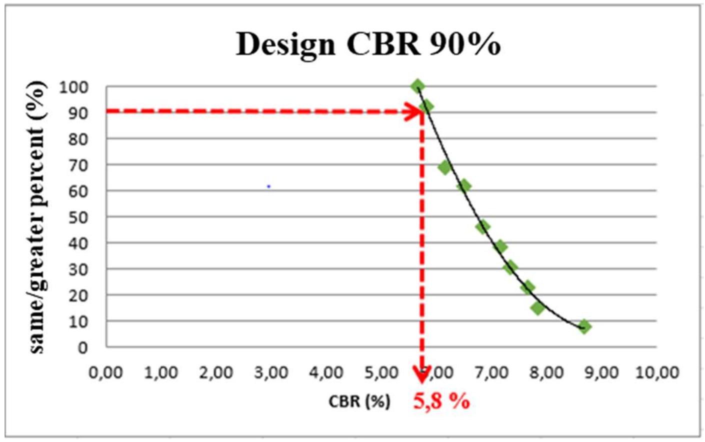

Figure 3. CBR Design 90%

b. Traffic Load Analysis

Table 2. Traffic Load Over the Planned Lifecycle of 40 Years

Vehicle Type	Number of trade axis groups	LHR 2022	Trade axis groups 2022	Trade axis groups 2022-2062
(1)	(2)	(3)	(4)=(2)x(3)	(5)=(4)x365xDDxDLxR
Gol. 5B	2	79	158	1950405,807
Gol. 6A	2	447	894	11035840,45
Gol. 6B	2	218	436	5382132,48
Gol. 7A	3	313	939	11591335,78
Gol. 7B	3	110	330	4073632,382
Total axle group of heavy vehicle 2022 - 2062				34033346,9
				3,4,E+07

In column (2), values for the number of commercial axes groups were obtained from Table 2, column (3) from the data from the field LHR survey. In column (4), it is obtained by multiplying column (2) by (3) so that as an example of the calculation, it is obtained 79 x 2 = 158 pcs. These results are used for calculations in column (5) so that the total JSKN results are obtained, namely 34 x 10^6

c. Pavement Layer Structure

After calculating the cumulative number of heavy vehicle axle groups during the design life of 40 years, the JSKN value is 34 x 106. This value's composition of the pavement thickness is in Table 3. From Table 3, the thickness of the pavement structure of the concrete slab is 295 mm, the thin concrete foundation layer (LMC) is 100 mm, and the bottom drainage layer is 150 mm.

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Table 3. Four Rigid Pavement Design Charts for Roads with Heavy Traffic Loads

Pavement Structure	R1	R2	R3	R4	R5
Heavy vehicle axle group (*overloaded*) (10E6)	< 4,3	< 8,6	< 25,8	< 43	< 86
Dowel and concrete shoulder			Yes		
PAVEMENT STRUCTURE (mm)					
Concrete plate thickness	265	275	285	295	305
Foundation layer (LMC)			100		
Drainage layer (can flow well)			150		

(Source: Road Pavement Design Manual, 2017)

d. Plate Reinforcement and Joints

In planning the reinforcement of the concrete slab, the initial data are known as follows:

a) plate thickness (h) : 29,5 cm = 0,295 m
b) plate width (L1) : 4 m
c) plate length (L_2) : 10 m
d) Friction coefficient of concrete slab with subbase (μ) : 1
e) steel clearance tensile strength (fs) : 240 MPa
f) density of concrete contents (M) : 2400 kg/m3
g) gravity (g) : 9.81 m/s^2

1) Longitudinal reinforcement calculation:

$$As = \frac{\mu \; x \; L2 \; x \; M \; x \; g \; x \; h}{2 \; x \; fs}$$

$$As = \frac{1 \; x \; 10 \; x \; 2400 \; x \; 9.81 \; x \; 0.295}{2 \; x \; 240} = 144{,}70 \; mm^2/m'$$

As min = 0,1% x 295 x 1000
= 295 mm^2 / m' > As needs
Using = Reinf. Ø12 mm – 200 mm
Reinf. check = (1000 : reinf. distance) x 3,14 x reinf. $radius^2$
= (1000 : 200) x 3,14 x 6^2
= 322,97 > As min … **OK**

2) Transverse reinforcement calculation:

$$As = \frac{\mu \; x \; L1 \; x \; M \; x \; g \; x \; h}{2 \; x \; fs}$$

$$As = \frac{1 \; x \; 4 \; x \; 2400 \; x \; 9.81 \; x \; 0.295}{2 \; x \; 240} = 57{,}88 \; mm^2/m'$$

As min = 0,1% x 295 x 1000
= 295 mm^2 / m' > As needs
Using = Reinforcement Ø8 mm – 150 mm
Reinf. Check = (1000 : reinf. distance) x 3,14 x reinf. $radius^2$
= (1000 : 150) x 3,14 x 4^2
= 334,93 > As min … **OK**

3) Dowel

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According to the 2017 MDPJ guidelines for determining the details of plate reinforcement, spokes, and tie rods still using the same method as the 2003 Pd T-14, the diameter of the reinforcement used is 36 with a distance of 300.

4) Tie Bars

Tie bars calculation with the Pd T-14 method in 2003, using the following formula:

At = 204 x b x h
= 204 x 4 x 0,295
= 240,7 mm^2 < surface area reinforcement. D19= 283,39 mm^2

I = (38,3 x Ø) + 75
= (38,3 x 16) + 75
= 687,8 mm = 700 mm = 70 cm

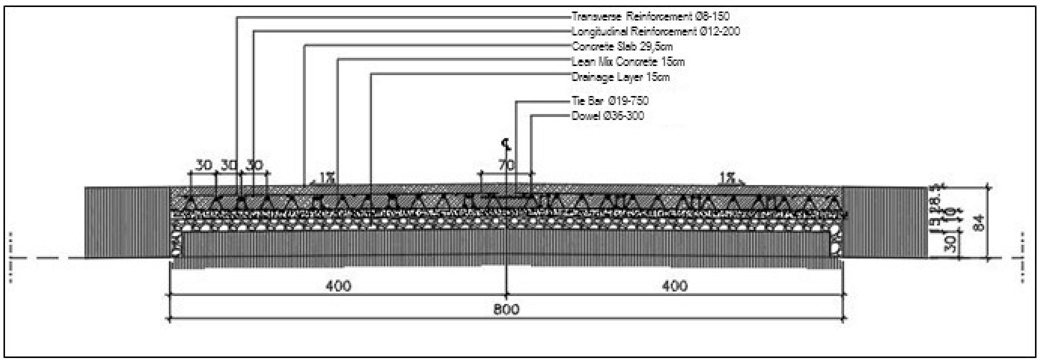

Figure 4. Rigid Pavement Design Result

4. Conclusions

The results of rigid pavement analysis using the 2017 MDPJ method obtained 29.5 cm with a 10 cm thick LMC (Lean Mix-Concrete) foundation layer and 15 cm drainage layer. The plate reinforcement used for longitudinal reinforcement is Ø12 – 200, and transverse reinforcement uses Ø8 – 150. Plate connection is used Ø36 – 300 for the length of 450 mm for the spokes, while the tie rods use D19 – 750 for 700 mm length.

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