

Road improvement from flexible pavement to rigid on Munjul - Panimbang Road Banten

Telly Rosdiyani^{1,*}, Gunawan Noor¹, and Irja Iswan¹

¹Civil Engineering Department, Banten Jaya University, Serang City Banten, Indonesia

Abstract. Roads are an important element in promoting public welfare. With the approach of regional development, the achievement of balance and equitable regional development. Munjul-Panimbang Road Section, a crossroads of tourist access and liaison between villages and sub-districts, this certainly requires an increase in roads in facilitating transportation mobility. Improving the pavement structure that has been declining is one of the solutions that must be done immediately by replacing the pavement flexure structure into concrete pavement (*Rigit Pavement*). This project has been completed, thereby analyzing the suitability of the Concrete Pavement Road Pavement Planning. This road improvement uses the Concrete Pavement Concatenated Pavement (BBDT) type, stretching the thickness of concrete plate and the required reinforcement diameter. The research method based on Concrete Pavement Concrete Pavement Planning, Pd T-14 2003. Primary data and secondary data are needed as supporting in research. The result of the analysis shows that concrete pavement planning is 15 cm thick concrete plaster and perforated reinforcement per meter using 5D15 mm - 200 mm, while crosslinks per meter of 2D10 mm - 500 mm can withstand the burden of vehicles traveling on the road with the age of 20 years.

1 Introduction

Road is one of the transportation infrastructure that makes it as an important element in promoting public welfare [1]. With the regional development approach, the achievement of regional development balance and equity, in the economic, social, political and cultural sectors [2,3]. The Munjul-Panimbang Road Section, a crossing of tourist access and links between villages and sub-districts, of course, requires an improvement in the way to facilitate transportation mobility. The lag behind development made Banten have to improve to pursue and equate the situation of other regions to accelerate development to make Banten superior.

The Munjul - Panimbang Road Section is located in Pandeglang Regency, which is a tourist road crossing and industrial area. The age of the Munjul-Panimbang road segment has been old enough, that the condition of the structure decrease in term of flexible road pavement, the growth of traffic in tandem with the growth of population is quite dense optimally, of course it makes the increase in ownership of vehicles passing on the road. The number of vehicles passing on the road with various types of vehicles required the selection of the right type of pavement to be able to withstand the burden of passing vehicles [4], so that road users can pass smoothly without obstacles. Under these conditions, rigid pavement becomes the choice in increasing the road in the section. The road

improvement with rigid road pavements is reflected determine the thickness of the rigid pavement in order to be able to withstand the load of vehicles passing on the road section, as well as to determine the diameter of the reinforcement required in the construction.

2. Research method

2.1 Research site

The location of the study was carried out on the Munjul - Panimbang Street Section of Pandeglang Regency, Banten Province



Fig. 1. Location map

* Corresponding author: tellyrosdiyani004@gmail.com

(Source: Department of highways and spatial Banten Province)

2.2 Data collection technique

The planning of rigid pavement road in Munjul-Panimbang Banten road requires data to be processed as a reference for determining the pavement thickness and diameter of the concrete slab reinforcement to support the load of vehicles passing through the section. The data collection techniques are carried out in the following ways [5]:

2.2.1 Literature Study

This is the way to collect secondary data to get the support of theories, documents, and relevant reference materials to researchers needs.

2.2.2 Interview

This is by interviewing reliable sources

2.2.3 Primary Data

This the way that the data is taken directly from the object under study consists of traffic data and results of interviews data from assistants the Technical Implementation Activities (PPTK) Department of Highways and Spatial Planning Banten Province

2.2.4 Secondary Data

This is data taken by researchers indirectly to measure the object of the researcher. It consists of map locatio, CBR value and etc.

2.2.5 Observation

This is the data obtained directly by visiting in the field, this is done at stages research preparation to determine the location of the study and identify the problem of field conditions

2.2.6 Literatur / reference book

This is the data obtained from reference books, NSPM (Standard Guidelines and Manual Norms) regarding research themes.

2.3 Analysis Method

Road Improvement on Munjul-Panimbang Road Section using rigid pavement, the target of planning is to determine the thickness and diameter of the reinforcement in order to be able to withstand the load of vehicles passing on the road. The planning process is shown in Figure 2. The results of the calculation process can be checked for patric damage analysis and erosion damage if the damage is less than 100% then the planning results are

good and if it exceeds 100% the design of the plate thickness must be reviewed [6].

This is based on Pd T14-2003 which is shown in Figure 3 on the next page

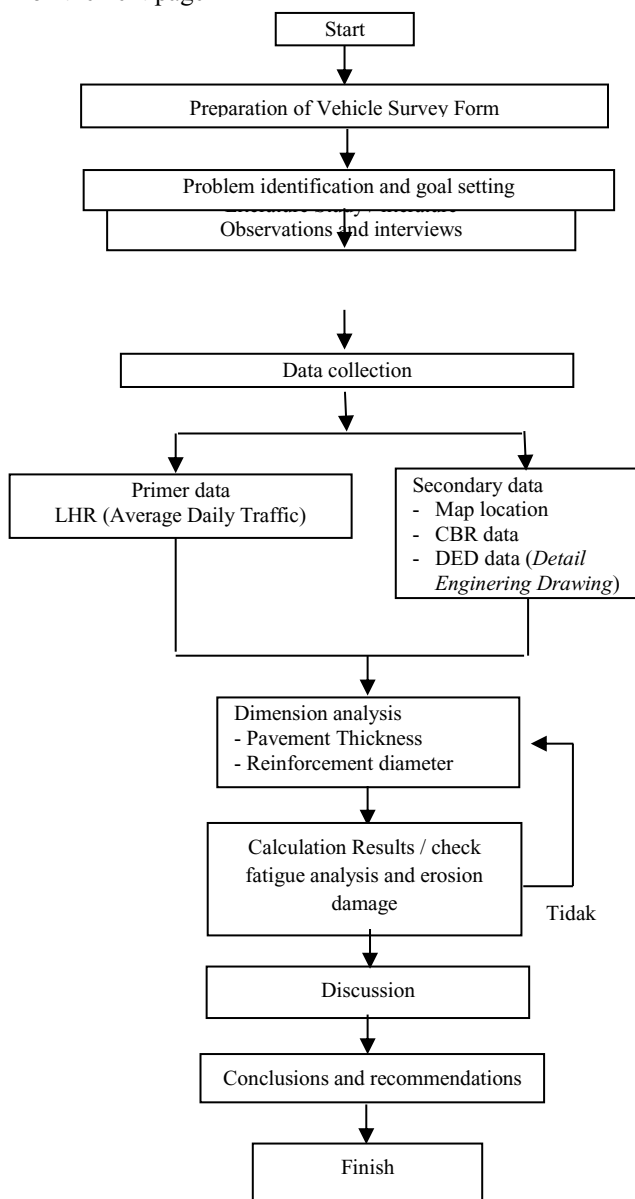


Fig. 2. Research flow chart

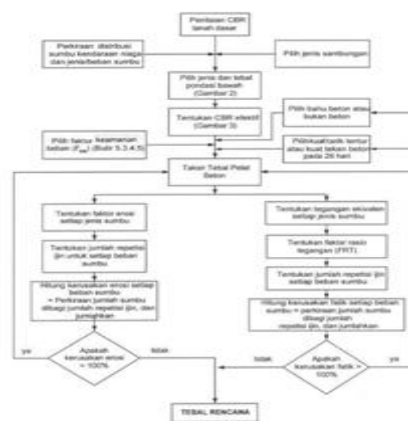


Fig. 3. Concrete pavement planning system

(Source: Pd-T14-2003)

3. Results and Discussion

3.1 Plate Thickness Calculation

Planning improvement of roads with rigid pavement on the Munjul-Panimbang road requires data including survey data. Rough traffic survey data can be obtained by calculating the volume of vehicles passing on the road for four hours, carried out on weekdays to represent another day showing the fluctuation of the vehicle.

Table 1. Total vehicle amount data

	Light Vehicle		
	Minibus Sedan Car, Jeep	Pick Up	Small Truck 2As
4 hours	247	25	28
VJP	62	6	7

	Heavy vehicle		
	Bus	Big truck 2As	Truck 3As
4 hours	18	13	5
VJP	4	3	1

(Source: Survey Results)

Based on Table 1 it can be seen that the number of vehicles that will cross a road section for 1 hour planning are minibus sedans, jeeps at most of the other vehicles are 62 vehicles.

- Load Data Sources : Survey Results
- Pavement Type : BBDT
- Shoulder Type : Concrete
- Plan Age : 20 Years
- JSK : 0.75 x105
- Load Safety Factor : 1.0
- Concrete Tensile Strength (fct) Age 28 days: 4.0 Mpa
- Subgrade CBR : 4%
- Effective CBR : 27%

Table 2. Vehicle amount recapitulation and load configuration

No	Type transport	Axis Load Configuration (tons)		No. of Vehicles (bh)	No. of Axes/vehicle (bh)	No. of Axes (bh)
		RD	RB			
(1)	(2)	(3)		(4)	(5)	(6)
1	MP 2 Tons	1	1	272		
2	Bus 8 Tons	3	5	18		36
3	2 As Truck small 6 Tons	2	4	28		56
4	2As Truck Big 13 Tons	5	8	13		26
5	3 As Truck Td 20 Tons	6	14	5		10
6	Total					128

Type Transport	STRT		STRG		STdRG	
	BS	JS	BS	JS	BS	JS
	(7)	(8)	(9)	(10)	(11)	(12)
Bus 8 Tons	3	18	5	18		
2 As Truck small 6 Tons	2	28				
2As Truck Big 13 Tons	4	28				
2As Truck Big 13 Tons	5	13	8	13		
3 As Truck Td 20 Tons	6	5			14	5
Total	92		31		5	

Source: Analysis Results

Where:

- RD = Roda Depan / Front wheel
- RB = Roda Belakang / Rear Wheel
- BS = Beban Sumbu / Axis Load
- JS = Jumlah Sumbu / Number of Axes
- STRT = Sumbu Tunggal Roda Tunggal / Single Wheel Single Axis
- STRG = Sumbu Tunggal Roda Ganda / Double Wheel Single Axis
- STDRG= Sumbu Tandem Roda Ganda / Double Wheel Tandem Axis

Number of Commercial Vehicle Axis (JSKN) during the plan life:

$$JSKN = 365 \times JSKNH \times R = 1.5 \times 10^5 \tag{1}$$

Where :

JSKN is the Number of Commercial Vehicle Axis
 R is the growth rate. For 5% in the table Factor of Traffic Growth in the Pd T-14 2003 guidelines, 33.07 was obtained by interpolasi while the JSKN plan was obtained for:

$$JSKN \text{ Plan} = C \times R \times JSKNH \times 365 \quad (2)$$

Where the table is shown as follows:

Table 3. Number of lines based on the commercial vehicle distribution coefficient

Pavement Width	Σ lane	Commercial Vehicles	
		1 Direction	2 Direction
< 5,5 m	1	1	1
5,5 m < Lp < 8,25 m	2	0,70	0,5
8,25 m < Lp < 11,25 m	3	0,50	0,475
11,23 m < Lp < 15,00m	4	-	0,45
15,00 < Lp < 22,00 m	5	-	0,425
18,75 m < Lp < 22,00m	6	-	0,40

Source: Pd-T14-2003

Based on Table 3 Rigid on Munjul - Panimbang Road Banten has a road width 6 meter so that number of lines based on the commercial vehicle distribution coefficient 0,5.

Table 4. Factor of traffic growth

Age of Plan (Year)	Growth Rate (i) Yearly (%)		
	0	2	4
5	5	5,2	5,4
10	10	10,9	12
15	15	17,3	20
20	20	24,3	29,8
25	25	32	41,6
30	30	40,6	56,1
35	35	50	73,7
40	40	60,4	95

Source: Pd-T14-2003

Age of Plan (Year)	Growth Rate (i) Yearly (%)		
	6	8	10
5	5,6	5,9	6,1
10	13,2	14,5	15,9
15	23,3	27,2	31,8
20	36,8	45,8	57,3
25	54,9	73,1	98,3
30	79,1	113,3	164,5
35	111,4	172,3	271
40	154,8	259,1	442,6

Source: Pd-T14-2003

Table 5. Axis plan repetition calculation

Axis Type	Axis Load (tons)	Number of Axes	Proportion of Expenses	Proportion of Axis
(1)	(2)	(3)	(4)	(5)
STRT	6	5	0,054	0,72
	5	13	0,141	0,72
	4	28	0,304	0,72
	3	18	0,196	0,72
	2	28	0,304	0,72
Total		92	1,00	
STRG	8	8	0,615	0,24
	5	5	0,385	0,24
Total		13	1,00	
STdRG	14	5	1,00	0,04
Total		5	1,00	

Axis Type	Traffic Plan	Repetition that occurs
	(6)	(7)=(4)x(5)x(6)
STRT	$0,75 \times 10^5$	$0,29 \times 10^4$
	$0,75 \times 10^5$	$0,76 \times 10^4$
	$0,75 \times 10^5$	$1,64 \times 10^4$
	$0,75 \times 10^5$	$1,05 \times 10^4$
	$0,75 \times 10^5$	$1,64 \times 10^4$
Total		
STRG	$0,75 \times 10^5$	$1,10 \times 10^4$
	$0,75 \times 10^5$	$1,69 \times 10^4$
Total		
STdRG	$0,75 \times 10^5$	$0,03 \times 10^4$
Total		
Kumulatif		$7,47 \times 10^4$

Source: Analysis results

Based on Table.5 above it can be seen that the values: Proportion of the bed in column 4 is obtained by the equation of division between the number of axes and the total number of STRT, STRG, or STdRG

with the following examples for STRT:

$$\frac{\text{Axis in total}}{\text{Total STRT}} = \frac{5}{92} = 0.054 \quad (3)$$

The proportion of axes in column 5 is obtained by the equation of division between the total number of axes and the number of axes based on the load with the following example:

For STRT axis proportion = $92/128 = 0.72$

JSK value of 0.747×10^5 with tensile strength of 4.0 Mpa, subgrade CBR of 4%, Effective CBR of 27% so that the estimated thickness of the concrete slab of 15 cm can be seen that the total fatigue that occurs <100% can be concluded calculation is sufficient and 15 cm plate thickness can be used.

3.2 Reinforcement planning

Reinforcement Planning is used based on the data obtained:

Plate friction coefficient with foundation (μ) = 1.3	MR Modulus Elastic Steel (Ice) = 20000 kg / cm ²
Connection distance (L) = 10 m	Steel Melt Voltage (f_y) = 3900 kg / cm ²
Plate Thickness (h) = 0.15 m	Modulus Elastic Concrete (E_c) = 1400 cfc
Steel Tensile Voltage (f_s) = 4.0 MPa	
Concrete Quality (f_c) = 40 kg / cm ²	
Concrete Specific Weight = 2400 kg / cm ²	
Concrete Tensile Strength (fct) 0.4-0.5 = 20 kg / cm ²	

Transverse Reinforcement

$$A_s = \frac{\mu \cdot L \cdot M \cdot g \cdot h}{2 \cdot f_s} \tag{4}$$

Lengthening Reinforcement

$$P_s = \frac{1 \cdot f_c \cdot (1.3 - 0.2 \cdot \mu)}{(f_y - n \cdot f_c)} \tag{5}$$

Where A_s is the reinforcement area
 Based on the data above, we obtained $A_s = 95.64 \text{ mm}^2$
 with $A_s \text{ min} = 0.1\% \times 150 \times 1000 = 150$
 $A_s \text{ Need} = P_s \times 100 \times \text{plate thickness}$, the reinforcement diameter can be determined by looking at the following Table:

Table 6 List of Reinforced Steel Section (cm²)

A	1	2	3	4	5
Ø8	0,5	1	1,5	2	2,5
Ø 10	0,79	1,58	2,37	3,16	3,95
Ø 12	1,13	2,26	3,39	4,52	5,65
Ø 15	1,76	3,52	5,28	7,04	8,80

A	6	7	8	9
Ø 8	3	3,5	4	4,5
Ø 10	4,74	5,53	6,32	7,1
Ø 12	6,78	7,91	9,04	10,11
Ø 15	10,56	12,32	14,08	15,84

Based on Table 6, List of Reinforced Steel Area, and calculation of reinforcement above A_s need to be obtained for the longitudinal reinforcement used is 5D15-200 while for transverse reinforcement used 2D10-500mm. Can be described below:

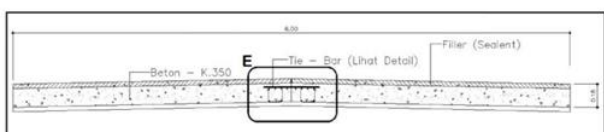


Fig. 4. Transverse reinforcement (Source: analysis results)

4. Conclusion

The results of road improvement planning data analysis using rigid pavement on Munjul-Panimbang Banten road based on Pd -T-14-2003 guidelines can be summarized as follows:

- The thickness of the concrete plate used to be able to withstand the load of vehicles passing on the Munjul-Panimbang road segment is 15 cm.
- Longitudinal reinforcement per meter using 5D15 mm - 200 reinforcement rods, while transverse reinforcement per meter using 2D10 mm reinforcement rod - 500 mm.
- The planning of the thickness of the concrete plate and the diameter of the reinforcement of the concrete plate are in accordance with the guidelines of Pd-T-14-2003 and have a level of security.

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