Road Improvement Overlay Pavement Flexible at Cibomo – Terumbu Road Serang City

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Abstract. Cibomo - Terumbu road to makes an alternative as connecting road (Axis) residential area in Kasemen District, Serang City. There are some damage conditions on the road structure and there is absence of adequate drainage channel with heavy traffic through the road, which lead congestion and inconvenience in driving. It is necessary to solve these problems. This research was conducted to determine the thickness of the pavement layer, and to design the dimensions of the drainage channel. The method used in this planning was the calculation of Bina Marga 1987. Geometric control of the road based on the Road Geometric Planning Basics 1999 , while drainage planning was used in the Procedure for Road Surface Drainage Planning (SNI-03-34241994) . Planning period for 15 (fifteen) years. The final results of the plan require an additional layer of 6 (six) cm Laston (Concrete Asphalt Surface Coating) MS 590. The size of the drainage channel in accordance with the calculation, channel height (h) is 0.40 m, the channel width (b) is 0.30, and the watch height (w) is 0.45.

1. Introduction

Road as one of the transportation infrastructure is an important element in the development of national and state life. Many roads are the main means of connecting that experience crisis conditions often occur before reaching the age of the plan such as Jalan Cibomo – Terumbu [1]. This could have happened due to several causes because the data of road pavement calculation in the planning period until the implementation was not in accordance with the parameter specifications that had been given and determined by the regulations and road planning guidelines issued by the regulations and road planning guidelines by Bina Marga [2, 3].

Physical conditions Jalan Cibomo – Terumbu has many holes, in which case this road is an alternative road as well as a connecting road (Poros) residential area in Kasemen District, Serang City, Banten Province [4-6]. The road was repaired in 2015. Visually, the road has damaged the structure of the road in several places, and does not have adequate drainage channels [7-9]. Population growth and vehicle ownership will spur increased population activity. The heavy traffic flow through the road section causes traffic jams and inconvenience in driving, so it is deemed necessary to address improvements in road conditions and services with flexible pavement overlay (flexible pavement). Thus the authors are interested in conducting to determine the thickness of the pavement layer, and to design the dimensions of the drainage channel [10, 11].

2. Research Method

2.1. Data Collection Technique

In road improvement overlay the flexible pavement on Cibomo – Terumbu Serang city, as supporting requiring data.To is done the collection of primary data and secondary. Primary data obtained from vehicle survey / interviewing related parties, while secondary data in the or map, technical specifications, implementation guidelines, NSPM (a norm, standard, guide and manual).

2.2. Analysis Method

As previously mentioned, this paper is about improving road pavement with the method of calculation spurring to Bina Marga to know the thickness pavement of overlay and dimensions of the drainage channel as for steps are planned as the flowchart shown in the Figure 1 below.
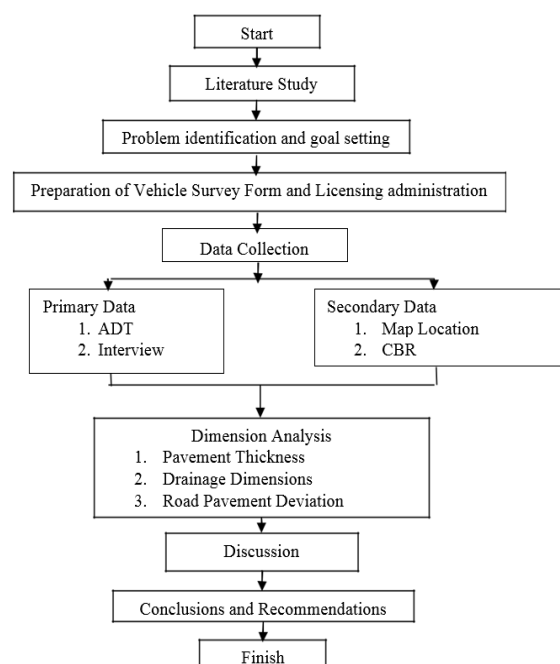

Figure 1. Flow Chart of Pavement Improvement Planning for Cibomo - Terumbu Road.

From Figure 1 above can be explained that the data obtained, primary data and secondary data, the next step is analyzing the data to plan the thickness of the asphalt layer for increasing Overlay and planning the dimensions of drainage channels, this calculation is also reviewed for the security stability set in the method calculation of Bina Marga. And the designed dimensions do not meet the security stability, the calculation will return or review the stage of determining the design of the layer thickness and dimensions of the road drainage channel.

3. Results and Discussion

3.1. Field Data

The data that the author can get from the Public Works Office of the City of Serang are as follows:

   i.   Pavement thickness for 1 lane and 2 directions.
  ii.   Population growth rate = 5%.
 iii.   The planned road is class III (Local road).

  iv.   Age of plan is 15 years.
  v.   CBR value is 4.
  vi.   ITP 4.78

The data obtained through the results of research in the field are the number of vehicles passing on Cibomo – Terumbu Road are as shown in Table 1.

Table 1. Number of vehicles passing in 1 day.

No	Types of Vehicles in Weight	Number of Vehicles
1	Light ride	230 Vehicles
2	Bus 8 ton	35 Vehicles
3	2 axles 10 ton truck	57 Vehicles
4	2 axles 13 tons trucks	10 Vehicles
	Total	332 Vehicles

3.2. Average Daily Trafic (ADT)
This data is for calculating the average daily traffic with the age of 15 while the results are shown in Table 2 below.

Table 2. Calculated members' stiffness

	Light ride	Bus 8 Ton	2 axles 10 ton truck	2 axles 13 tons trucks
ADT	478.15	72.76	118.50	20.79

3.3. Calculation Of The Equivalent Number Of Axle Loads
The value of the equivalent number of axle loads are as shown in Table 3.

Table 3. Value the equivalent number of axle loads

	Light ride	Bus 8 Ton	2 axles 10 ton truck	2 axles 13 tons trucks
E	0.0004	0.1593	0.3500	1.0648

3.4. Calculation Of The Equivalent Number Of Axle Loads
This calculation is to know the cross equivalent to the method:

Light Ride (1+1):	230 x 1.0 x 0.0004 = 0.092
Bus 8 ton (3 + 5):	35 x 1.0 x 0.1593 = 5.576
2 axles 10 ton Truck (4+6):	57 x 1.0 x 0.3500 = 19.95
2 axles 13 ton Truck (5+8):	10 x 1.0 x 1.0648 = 10.64
	Total Perminal Equivalent = 36.266

3.5. Final Equivalence Calculation
It is the sum of the average daily equivalents of a single axis as heavy as 8.16 (18000 lb). On the path of the plan:

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Light Ride (1+1):	478.15 x 1.0 x 0.0004 = 0.191
Bus 8 ton (3 + 5):	72.76 x 1.0 x 0.1593 = 11.591
2 axles 10 ton Truck (4+6):	118.49 x 1.0 x 0.3500 = 41.475

2 axles 13 ton Truck (5+8):   20.789 x 1.0 x 1.0648 = 22.136
                                 Total Final Equivalent = 75.393

3.6. Final Equivalence Calculation
Cross-calculation is equivalent 15 year obtained:

Central Cross Equivalent 15:   = ½ x (Perminal Equivalent + Final Equivalent
Bus 8 ton (3 + 5):   = 0.5 (36.266 + 75.393) = 55.829

3.7. Calculation of Equivalent Cross Plan
Calculation of equivalent cross plan is as follows:

Equivalent Cross Plant   = Final Equivalent x Central Cross Equivalent where is the value CCP
                            = (age of plan /10)
                            = 55.829 x (15/10) = 83.74

3.8. Determine The Value of Regional Factors (FR)
Determine the value of FR with consideration of less than 6% and the regional climate is less than 900 year so regional factors can be used on the Cibomo-Terumbu road which is 1.0 - 1.5

3.9. Determine The Value Of The Surface At The End Of Age Plan (IP)
Determine the value of index see of the value of traffic equivalent plan is 83.74 and Roads are local roads and surface value index of 1.5

3.10. Determine The Value Of CBR
Segments can be determined using analytical or graphical methods, known data in the CBR field = 8, 6, 5, 4, 5, 5, 4, 5, and 3 which is shown in Table 4 below. Based on Table 4, the CBR value is taken by CBR 4 which shows 90%.

Table 4. Value of CBR

CBR	Same or More Amount	Percent (%) Equal Or Greater	
3	9	9/9 x100 = 100	100
4	8	8/9 x 100 = 100	88,9
5	6	6/9 x 100 = 100	66.7
6	2	2/9 x 100 = 100	22.2
8	1	1/9 x 100 = 100	11.1

3.11. Determine the Carrying Capacity of the Land
After setting the value CBR so capacity land was obtained through interesting way a straight line on diagram Soil support so that the CBR 4 found soil support value of 4.3 tons.

3.12. Determine the value of ITP
The pavement thickness index was obtained using a nomogram, determining Cross Equivalent at 83.74, using the Laston surface type and value 3.9 - 3.5, the surface index value at the end of the 1.5 plan, the writer determines the Nomogram number 5 as shown in Figure 2 below.
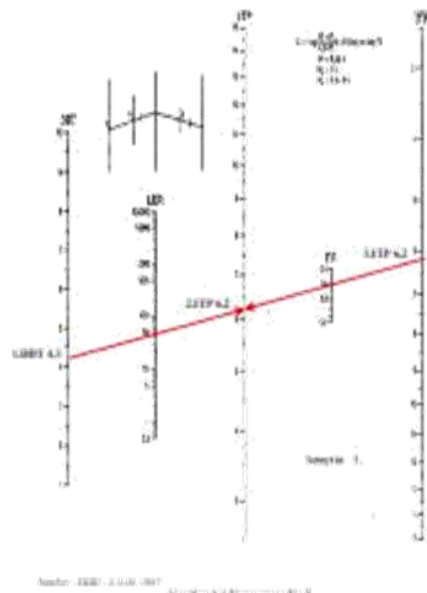
Figure 2. Flow Chart of Pavement Improvement Planning for Cibomo - Terumbu Road.

3.13. Determine the add Layer Thickness

Surface layer thickness in road conditions is assumed to be 25% reduced, conditions in the field with a thickness of 4 cm using laston MS 590 which have a relative strength coefficient of 0.35, the thickness of the upper foundation layer does not experience conduction in the field 10 cm thick and uses stone broken (CBR 100) which has a relative strength coefficient of 0.14. Lower foundation thickness in road conditions 20 cm thick. So that the Additional Layer Thickness:

Land Strength
Laston (MS 590) 4 cm = 75% x 4 x 0.35   = 0.78
Broken stone class A   = 100% x 0.14 = 1.40
Broken stone class B   = $\underline{100\% \times 20 \times 0.13 = 2.60}$
                         ITP =   4.78

$IPT = ITP_{15} - ITP$
     = 2.11

$1.41 = 0.35 \times D_1$, so D_1 = 6.04 or 6 cm

3.14. Road Drainage Planning

3.14.1. Calculation of Debit Flow Plans (Q)
The calculation of the debit flow plans are as follows:

Length of channel plan   : 400 m
Width of drainage area
I_1 Road Pavement = 2.25 ; I_2 Roadside = 0.5 m ; I_3 Outside road = 10 m
Area of Jetting;.
A_1 Road Pavement   = 2.25 x 400 = 900 m^2
A_2 Roadside   = 0.5 x 400 = 200 m^2
$\underline{A_3\text{Outside road}}$ = 10 x 400 = 4000 m^2 km^2
Total Large   =5.100 m^2 = 0.00510   km^2

3.14.2. Calculation the Average Flow Coefficient
Use the average flow coefficient

Table 5. Flowing coefficient

Soil Surface Conditions	Coefficient Streaming (c)		Runoff Factor (fk)
Ingredients			
1. Concrete road and asphalt road	0.70	-0.95	
2. Gravel road & dirt road	0.40	-0.70	
3. Roadside			
- Fine-grained soil	0.40	-0.65	
- Coarse grained soil	0.10	-0.20	
- Massive rock hard	0.70	-0.85	
- Soft massive rock	0.60	-0.75	
Land use			
1. Urban area	0.70	-0.95	2.0
2. Suburban area	0.60	-0.70	1.5
3. Industrial Area	0.60	-0.90	1.2
4. Dense settlement	0.60	-0.80	2.0

3.14.3 Counting The Time Of Concentration
The time of concentration or Tc is the longest time needed by the service area in channeling water flow.

$Tc = T1 + T2$ (3)
Where :
Tc = Time of concentration
T_1 = The time needed to reach the start of the channel from the point Farthest
$T2$ = Time of flow in channels along L from the upstream end
I_0 = Distance from the farthest point to the drainage facility (m)
L = Channel length (m)
nd = Coefficient of resistance
Is = The channel slope is elongated
V = Average speed in the drainage channel (m/second)
Then the time of the road concentration is equal to:
T_1 = T_1 Road Pavement + T_1 Roadside + T_1 Outside road
Where:
I_0 = 2.25 make
        = ($\quad$ x 3.28 x I_0 x) ^{0,167} = 0.784 minutes

T_1 Roadside
Where:
I_0 = 0.5 make T_1 Roadside as to 0.93 minutes

T_1 Outside road
Where
I_0 = 10 make T_1 Outside road as to 1.783 minutes

Total T_1 is 3.531 minutes and can be known value T_2 as 3.333 minutes then the amount of time for the

Cibomo -Terumbu road concentration is:

Tc $= T_1 + T_2$

Tc $= T_1 + T_2$

3.14.4 Rainfall Data Analysis

The maximum mean data is taken from the BMKG class 1 Serang Station in 2016 as follows:

Table 6. Maximum Average Rainfall Data

No	Month	Rainfall (mm)	Day Rain
1	Jan	125.9	19
2	Feb	271.9	26
3	Mar	228.8	23
4	Apr	88	19
5	May	143.3	18
6	Jun	93	13
7	Jul	134.8	16
8	Aug	86.6	16
9	Sep	158.9	24
10	Oct	164.8	24
11	Nov	138	22
12	Dec	178.8	22
Total		1812.8	242
Average		151,07	
Maximal		271.9	

The results of the calculation of the rainy day are as follows:

Table 7. Result of Calculation of Rain reoccurs

No.	T (Year)	Rainfall (mm)	Rounding (mm)
1	2	151.07	151
2	5	197.97	198
3	10	222.54	222
4	15	234.06	234

3.14.5 Rainfall Intensity Analysis

The calculation method is used as follows:

$$I = \{(R/24)\} \times \{(24/Tc)\}^{2/3} \tag{4}$$

Where:

I   is the intensity of rain in mm / hour

Tc   is the Time of Concentration in Hours

R   is design rainfall in mm

        is the Time of Concentration in Hours

3.14.6 Calculate Flow Discharge (Q)
Calculate the flow rate based on the Pd T-02-2006 guideline on road drainage system planning

I $= \{(R/24)\} \times \{(24/Tc)\}^{2/3}$

   Where:

Q   = flow (m^3/sec.)
C   = Average Flowing Coefficient
I   = Rainfall intensity (mm/hr)
A   = area service (km^2) consists of A$_1$, A$_2$, A$_3$

then value Q obtained 0.165 m^3/sec

3.14.7 Calculating Channel Dimensions
Planned in the form of a square with concrete materials with the following conditions:

Allowable flow rate	= 1.5 m3 / sec
Lengthened channel slope	= 1.5%
Coefficient of material roughness according to the stone pair channel	= 0.020 from the SNI data
Flow discharge	= 0.165 m3 / sec
Channel base	= 0.75
	= 0.75 h^2
Wet circumference of the channel Ps	= b + 2 h
	= 2.75 h
Hidraulic Radius	= Fs/Ps
	= 0.273 h
Formula Manning V	= 1/n x Rs$^{2/3}$ x I$^{1/2}$
	= 2.577 h$^{2/3}$
Make Q	= Fs. V
0.165 m^3/sec	= 0.75 h^2 x 2.577 h$^{2/3}$
h$^{8/3}$	= 0.085
h	= 0.085$^{3/8}$ = 0.40 ; b = 0.3 m
Hence the dimensions of the drainage channel h	= 0. 40 m and b = 0.30 m

3.14.8 Security Height (W)
Using formulas:

W =   (11)

Then the value of w is obtained 0.45 m

3.14.9 Control Channel Dimensions

A   = Flow speed
               = 0.12 m^2 ;
wet roving   = 1.1 m
Hydraulic radius   = 0.109 m
Flow speed = 1.86 m/ sec.
Q   = A.V = 0.223 m^3/ sec. $\geq$ 0.165 m^3/ sec

4. Conclusions
From the description above, this study can be concluded as follows:

i.   Total overlay of asphalt concrete for Cibomo – Terumbu road with a thickness of 6 (six) cm, uses laston MS 590.

ii.   The size of the drainage channel in accordance with the calculation, the channel height (h) is 0.40 m, the channel width (b) is 0.30, and the watch height (w) is 0.45.

iii.   Pavement Deviation Bending Cibomo – Terumbu road in the results of the review have a difference of 2 cm in the age of the plan of 15 years.

To support conclusions, the suggestions that can be conveyed by the author are as follows:

i.   In road planning, it is expected that the planner must also plan road drainage to avoid flooding or standing water on the pavement so that the road is more durable.

ii.   In connection with the field conditions that affect the construction of the pavement layer supporting the spread of the load, the type of material used must be in accordance with the local soil conditions

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