

Overlay Planning and Budget Estimation for the Kartini–KH. Ahmad Dahlan Road Segment in Batam City

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Abstract—Road damage occurring across various regions has become a complex issue, resulting in significant losses—particularly for road users. These impacts include increased travel times, traffic congestion, higher risk of road accidents, and other related problems. The determination of the additional overlay thickness for the Kartini–KH. Ahmad Dahlan road segment was carried out by calculating the CESA4 and CESA5 values, which were then multiplied by a traffic multiplier. Based on this analysis, the minimum required overlay thickness was determined to be 4 cm. Based on the design and evaluation results, the budget estimation for the Kartini–KH. Ahmad Dahlan road segment (Sta. 00+000 to 02+000) amounted to Rp. 4,294,713,000.

Keywords—Overlay, budget, road

1. INTRODUCTION

The Kartini–KH. Ahmad Dahlan road segment frequently experiences surface cracking and potholes, primarily due to the passage of heavy vehicles such as private cars, buses, two-axle trucks, and three-axle trucks. The continuous annual increase in average daily traffic has contributed to excessive loading on the road structure. In addition to traffic-induced stress, prolonged waterlogging during the rainy season—caused by inadequate drainage systems—has further accelerated damage to the flexible pavement layer, resulting in repeated surface deterioration.

Road damage occurring in various regions today represents a complex problem that results in significant losses, especially for road users—such as increased travel time, congestion, and traffic

accidents. The initial step in addressing such damage is conducting a road condition survey. Accurate condition assessments are essential to ensure appropriate and effective maintenance strategies. On the Kartini–KH. Ahmad Dahlan road segment, the predominant types of damage observed are cracking and numerous potholes across multiple segments. Considering the current road conditions, this study aims to determine the required overlay thickness and develop a cost estimate for the Kartini–KH. Ahmad Dahlan road segment. The condition of the road segment can be observed in the following figure.



Figure 1.1 Condition of road

Road maintenance planning must be conducted thoroughly and in detail, taking into account the existing damage in order to achieve economic efficiency, ensure road user safety, and maintain the required pavement thickness quality.

2. THEORETICAL FRAMEWORK

2.1 Design life

In determining the design life, it is essential to consider the road capacity to accurately establish the design life to be used in pavement planning.

$$C = C_O \times FC_{LJ} \times FC_{PA} \times FC_{HS}$$

2.2 Traffic Growth Factor

The traffic growth factor is derived from time-series growth data through a formulation that correlates with other applicable growth factors.

$$R = \frac{(1+0,01 i)^{UR-1}}{0,01 i}$$

2.3 Cumulative Equivalent Single Axle Load (Cumulative ESAL)

The Cumulative Equivalent Single Axle Load (CESAL) refers to the total cumulative design axle loads acting on the design lane throughout the specified design life. The calculation utilizes the Vehicle Damage Factor (VDF) corresponding to each category of commercial vehicles

$$ESAL_{TH-1} = (\Sigma LHR_{JK} \times VDF_{JK}) \times 365 \times DD \times DL \times R$$

2.4 Traffic Multiplier (TM)

The Traffic Multiplier (TM) for asphalt layers under overloaded traffic conditions in Indonesia typically ranges from 1.8 to 2. In flexible pavement design, the Traffic Multiplier must be applied to obtain the adjusted Cumulative Equivalent Single Axle Load for 5-year design traffic (CESA5)

$$CESA5 = (TM \times CESA4)$$

2.5 Dynamic Cone Penetration Test

This test is intended to determine the California Bearing Ratio (CBR) value of the subgrade soil. However, the Dynamic Cone Penetrometer (DCP) cannot be used on hard materials such as hotmix asphalt or rock, as this may damage the penetration cone

2.6 Design of Flexible Pavement Foundation

Pavement foundation design is a critical requirement to ensure high-performing pavement structures. A normal subgrade is generally defined as a subgrade with an in-situ CBR value greater than 2.5%, including areas composed of embankments, excavations, and natural ground surfaces.

2.7 Budget Estimation

The Budget Estimation is a calculation or estimate of the total financial cost required to complete a construction project.

$$\text{Budget} = \Sigma (\text{Volume} \times \text{Unit Price})$$

3. METHODOLOGY

3.1 Flowchart

The type of research employed in this study is quantitative research. This method

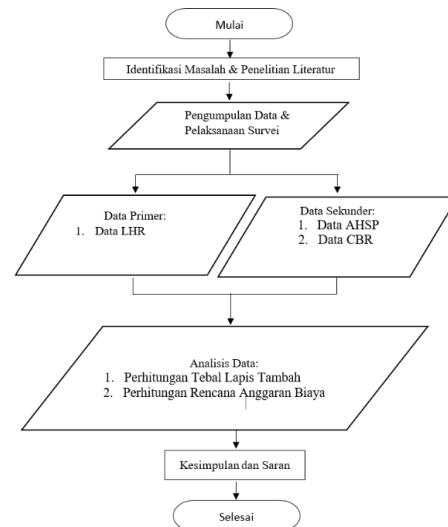


Figure 3.1 Flowchart

involves the collection of statistical data for analysis, which can be presented in the form of graphs, charts, tables, and hypothesis testing.

4. RESULTS

4.1 Traffic Growth Analysis

According to the Indonesian Road Capacity Guidelines 2023, the conversion from light vehicle units per day (skr/day) to skr/hour is performed by multiplying with a K factor of 0.08. The following is the calculation of light vehicle units based on the 2025 daily traffic volume

Table 4.1. Vehicle Unit Calculation Table for Average Daily Traffic in 2025

No	Vihecles	LHRT 2025 (kend/hr)	ekr	LHRT x ekr (skr/hr)	Faktor K	LHRT x K (skr/hr)
1	Motorcycle	763	0.50	382	0.08	31
2	Car	400	1.00	400	0.08	32
4	Two-Axle Light Truck	92	1.30	119	0.08	10
5	Two-Axle Medium Truck	11	1.30	14	0.08	1
Total		1265.5		914.75		73.18

Source: Researcher's Own Analysis, 2025

Table 4.2. LHR-JK 5Th

No	Vehicles	LHRTK 2025	5 Th	
			R	LHR-JK
1	Motorcycle	31	5.0	183
2	Car	32	5.0	192
4	Two-Axle Light Truck	10	5.0	57
5	Two-Axle Medium Truck	1	5.0	7
Total		73		439

Source: Researcher's Own Analysis, 2025

4.2 Cumulatif Equivalent Single Axle (CES4)

The Cumulative Equivalent Single Axle Load (CESA) result was derived based on the following analysis:

Table 4.3. CESA4

Gol	Jenis Kendaraan	Konf Sumbu	LHRJK	VDFJK	DD	DL	R	ESA
1	Motorcycle		183	0	0.5	1	5.0	-
2	Car	1.1	192	0	0.5	1	5.0	-
6a	Two-Axle Light Truck	1.1	57	0.55	0.5	1	5.0	28,692
6b	Two-Axle Medium Truck	1.2	7	4	0.5	1	5.0	25,086
Total			439	CESA4				53,778

Source: Researcher's Own Analysis, 2025

4.3 Traffic Multiplier (TM)

The traffic multiplier (TM) for asphalt layers in Indonesia ranges from 1.8 to 2.0; therefore, the average value of 1.9 is adopted for the calculation.

Table 4.4. CESA5

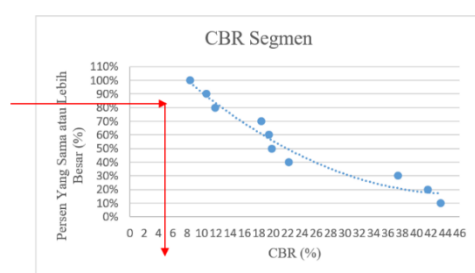
Gol	Jenis Kendaraan	Konf Sumbu	CESA4	TM	CESA 5
1	Motorcycle		0	1.9	-
2	Car	1.1	0	1.9	-
6a	Two-Axle Light Truck	1.1	28692	1.9	54,515
6b	Two-Axle Medium Truck	1.2	25086	1.9	47,663
Total			3,777.63		102,177

Source: Researcher's Own Analysis, 2025

4.4 California Bearing Ratio (CBR)

Determining the field CBR test points to be used in calculating the segmental CBR value

The CBR segment value was obtained by drawing a line from the 90% CBR design level until it intersected the graph curve, then projecting it downward. As a result, the segmental CBR value was determined to be 10.5%.



Grafik 4. 1 CBR segmen

4.5 Determining the Pavement Structure

Based on the selected pavement structure, the proposed solution involves the use of Asphalt Concrete (AC) in combination with Granular Base Course

Table 4.5. Flexible Pavement Design – Asphalt with Granular Base Course

	F(1)1	F(1)2	F(1)3	F(1)4	STRUKTUR PERKERASAN					
	F(1)5	F(1)6	F(1)7	F(1)8	F(1)9	F(1)10	F(1)11	F(1)12	F(1)13	
Untuk beban rencana < 30 juta ESAS menggunakan Aspal Pen 60-70					Untuk beban rencana ≥ 30 juta ESAS direkomendasikan menggunakan Aspal PG70					
Beban rencana 20 tahun (10 ⁶ ESAS)	> 1 - 8				> 8 - 10				> 10 - 20	
Jenis material berpaspal	> 10 - 20				> 20 - 30				> 30 - 40	
Jenis lapis fondasi	> 40 - 50				> 50 - 60				> 60 - 70	
	> 70 - 80				> 80 - 90				> 90 - 100	
	> 100 - 150				> 150 - 200				> 200 - 300	
	> 300 - 400				> 400 - 500				> 500 - 600	
	> 600 - 700				> 700 - 800				> 800 - 900	
	> 900 - 1000				> 1000 - 1500				> 1500 - 2000	
	> 2000 - 3000				> 3000 - 4000				> 4000 - 5000	
	> 5000 - 6000				> 6000 - 7000				> 7000 - 8000	
	> 8000 - 9000				> 9000 - 10000				> 10000 - 15000	
	> 15000 - 20000				> 20000 - 30000				> 30000 - 40000	
	> 40000 - 50000				> 50000 - 60000				> 60000 - 70000	
	> 70000 - 80000				> 80000 - 90000				> 90000 - 100000	
	> 100000 - 150000				> 150000 - 200000				> 200000 - 300000	
	> 300000 - 400000				> 400000 - 500000				> 500000 - 600000	
	> 600000 - 700000				> 700000 - 800000				> 800000 - 900000	
	> 900000 - 1000000				> 1000000 - 1500000				> 1500000 - 2000000	
	> 2000000 - 3000000				> 3000000 - 4000000				> 4000000 - 5000000	
	> 5000000 - 6000000				> 6000000 - 7000000				> 7000000 - 8000000	
	> 8000000 - 9000000				> 9000000 - 10000000				> 10000000 - 15000000	
	> 15000000 - 20000000				> 20000000 - 30000000				> 30000000 - 40000000	
	> 40000000 - 50000000				> 50000000 - 60000000				> 60000000 - 70000000	
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	> 900000000 - 1000000000				> 1000000000 - 1500000000				> 1500000000 - 2000000000	
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	> 900000000000000000000000000 - 1000000000000000000000000000				> 1000000000000000000000000000 - 1500000000000000000000000000				> 1500000000000000000000000000 - 2000000000000000000000000000	
	> 2000000000000000000000000000 - 3000000000000000000000000000				> 3000000000000000000000000000 - 4000000000000000000000000000				> 4000000000000000000000000000 - 5000000000000000000000000000	
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4.7 Budget Estimation

Based on the research conducted on the Kartini–KH. Ahmad Dahlan road segment STA 00+000 – 05+000, the following budget estimate has been determined:

Table 4.5. Budger Estimation

No	STA		Budget
	Start	Finish	
1	00+000	00+200	Rp 239,408,962.98
2	00+200	00+400	Rp 239,460,151.70
3	00+400	00+600	Rp 239,469,170.47
4	00+800	01+000	Rp 239,463,081.11
5	01+000	01+200	Rp 239,896,375.50
6	01+200	01+400	Rp 239,814,866.45
7	01+600	01+800	Rp 239,907,595.46
8	01+800	02+000	Rp 239,460,925.59
9	02+000	02+200	Rp 239,653,148.32
10	02+200	02+400	Rp 239,431,937.08
11	02+400	02+600	Rp 239,563,624.76
12	02+600	02+800	Rp 239,461,482.81
13	02+800	03+000	Rp 240,021,442.55
14	03+000	03+200	Rp 240,643,588.80
15	04+000	04+200	Rp 239,387,253.99
16	04+800	05+000	Rp 239,521,449.06
TOTAL BUDGET			Rp 3,834,565,056.63
PPN 12%			Rp 460,147,806.80
TOTAL BUDGET + PPN 12%			Rp 4,294,712,863.42
ROUNDED			Rp 4,294,713,000.00

Source: Researcher's Own Analysis, 2025

Based on the table above, the estimated project cost for the Kartini–KH. Ahmad Dahlan road segment STA 00+000 – 05+000 is IDR 4,294,713,000.00

5. CONCLUSION

Based on the data analysis and in accordance with the research questions, the following conclusions were drawn:

1. The overlay design for the Kartini–KH. Ahmad Dahlan road segment resulted in a flexible pavement thickness of 4 cm for the Asphalt Concrete Wearing Course (AC-WC).
2. The maintenance cost estimate for the Kartini–KH. Ahmad Dahlan road segment amounts to IDR 4,294,713,000

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