PLANNING FOR IMPROVING ROAD CLASS ON ROAD ACCESSTO RAHADI OESMAN AIRPORT KETAPANG-WEST KALIMANTAN

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ABSTRACT
Rahadi Oesman Airport is located in Ketapang Regency, West Kalimantan. However, the airport terminal has different roads due to limited road access for vehicles, because residents use the terminal exit access to do things outside of aviation activities. The reference used is Ministerial Regulation No. 78 of 2014 and Standard Unit Prices for Goods Needed by the Ketapang Regency Government in 2024. The improvement plan for the road has an AC-WC layer thickness of 50 mm, a LFA of Class A 220 mm, a LFA of Class B 150 mm, and a stabilized subgrade layer of 200 mm, the calculation results are using the Road Pavement Design Manual method No. 03/M/BM/2024 with the required budget of IDR 525,560,000.00.

Keywords: *Airports, Road Improvements, Road Pavement Design Manual No. 03/M/BM/2024, Pavement Thickness, Cost Budget Plan.*

1. INTRODUCTION

Rahadi Oesman Airport has few roads for vehicles because most terminal entrances and exits have separate access roads, according to Government Regulation Number 40 of 2012 concerning Airport Development and Environmental Preservation. Rahadi Oesman Airport currently still uses public road access for traffic which residents around the airport use for purposes other than aviation activities, such as dropping off passengers or picking up passengers. This causes the exit route from the airport terminal to be irregular and causes chaos [1].

Regulated in Ministerial Regulation Number 33 of 2015 concerning Control of Entrance Roads to Airport Restricted Security Areas, the activities of residents seriously disrupt the security, order, and smooth running of Rahadi Oesman Airport [2]. This is because there is no separate exit access that can be closed, so everyone in the airport terminal area can carry out their activities there, whether they are passengers or not. Rahadi Oesman Airport currently has an access road measuring ± 167 m long and 6 m wide.

The Rahadi Oesman Airport access road is included in a group of special roads not used by general traffic. These roads are only available for the benefit of individuals, social groups, companies, or certain agencies, following the road grouping system specified by Circular Letter Number 20 concerning Road Geometric Design Guidelines for the Ministry of Public Works and Public Housing in 2021 [3].

According to the description in the context of the background and identification of the problem, the problem formulated is:

1. What is the design of the road class improvement plan for the road access to Rahadi Oesman Ketapang Airport?
2. How thick is the pavement to increase the road class on the access road to Rahadi Oesman Ketapang Airport?
3. How much cost is needed to improve road access to Rahadi Oesman Ketapang Airport?

1.1 Airport Definition

Regulations issued by the Minister of Transportation of the Republic of Indonesia Number PM 38 of 2015 concerning Domestic Air Transport Passenger Service Standards, an airport is an area on land and/or waters with certain boundaries that are used as a place for aircraft to land and take off, boarding and disembarking passengers, loading and unloading of goods, and movement of intermodal and intermodal transportation, which is equipped with aviation safety and security facilities, and other supporting facilities [4].

1.2 Airport Support Facilities

According to SKEP 347/ XII/1999, the function of airport supporting facilities is to improve the smoothness and safety of airport operations and consists of landside infrastructure. such as roads, parking, clean water, and waste, along with supporting facilities [5]. The functions of the supporting facilities themselves are as follows:

1. Facilitate the flow of passenger cars and goods at the airport.
2. Collects and distributes utilities such as water and waste.
3. Increase the sense of security and clarify existing boundaries at airports.
4. Creating a sense of security and comfort for customers and airport employees.
5. M accommodates planned parking activities at the airport.

1.3 Roads and Parking

At an airport, there are other supporting facilities to maximize airport operational activities. These supporting facilities include roads and parking. Referring to SKEP 347/XII/1999 [5] the parking and road elements consist of:

1. The road body is the part of the road layer with pavement for vehicle traffic.
2. Road shoulder, the right and left side of the road leading to the parking area which is equipped with curbs *and* limits the movement of vehicles.
3. Median, is a part of the road that functions as a divider between the right lane and the left lane.
4. The left and right channels of the road are part of an open or closed channel which has the function of collecting and channeling wastewater or rainwater.

1.4 Airport Entrance Road

Referring to SKEP 347/XII/1999 the airport entrance road has a connecting function from the public road to the airport terminal [5]. Planning regarding airport entrances includes forecasting traffic volume, and the number of lanes per road, as well as determining green lanes, sidewalks, and channels.

1.5 Inspection Road

Inspection roads are used for routine inspection of basic airport facilities and are built around airport boundaries and connect runways with operating roads. According to the Directorate General of Civil Aviation, emergency vehicles such as the PKP-PK fire brigade also use this road.

1.6 Operation Path

This operational road was built for PKP -PK emergency vehicles and airport basic facility inspection roads.

1.7 Service Road

The service road serves vehicles that transport routine airport needs and functions as a road connecting the passenger terminal to the operations building.

1.8 Neighborhood Road

Neighborhood roads are located within housing complexes and can serve vehicles of housing owners and PKP-PK.

1.9 Planning for Improving Airport Access Road

One important aspect of airport supporting facilities is road access to the airport. This is necessary to make it easier for prospective passengers and passengers to access the airport. The access road to the airport is one of the things that prospective passengers take into account when using airplane transportation.

1.10 Understanding the Road

Roads are an important element in the world of transportation, especially land transportation. People use roads to move. According to Article 1 Paragraph 4 of Law Number 38 of 2015 concerning Domestic Air Transport Passenger Service Standards, roads are land transportation infrastructure that is at ground level, above ground level, below ground level, or above water level, except for roads trains, lorry roads, and cable roads [4].

1.11 Stages of the Road Pavement Design Manual Method Number 03/M/BM/2024

In the road pavement planning process, Bina Marga uses the Road Pavement Design Manual Number 03/M/BM/2024. The 2024 Road Pavement Design Manual is a guide for road technical planners in Indonesia. This is an update of the 2017 Road Pavement Design Manual and uses empirical mechanistic methods.

2. RESEARCH METHODS

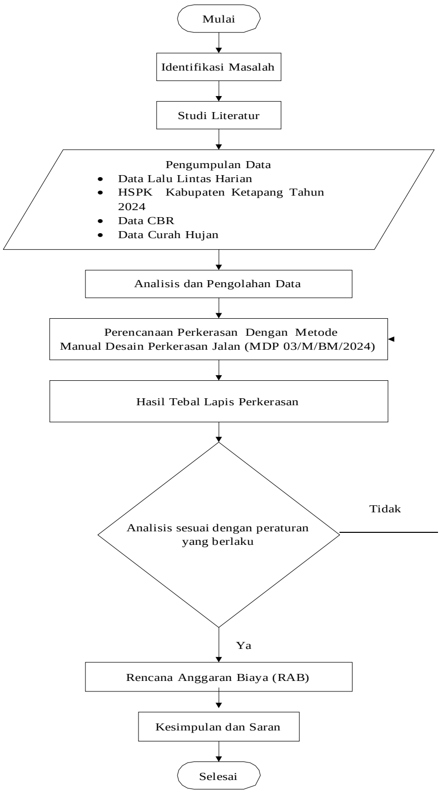


Figure 1 Planning Flow Chart

2.1 Stages of the Road Pavement Design Manual Method Number 03/M/BM/2024

In the road pavement planning process, Bina Marga uses the Road Pavement Design Manual Number 03/M/BM/2024. The 2024 Road Pavement Design Manual is a guide for road technical planners in Indonesia. This is an update of the 2017 Road Pavement Design Manual and uses empirical mechanistic methods.

2.2 Types of Work Structures

Flexible pavement structural layers have certain tasks and functions. The following is the function of each pavement layer structure:

1. Basic Land

   The surface used to lay the pavement structure is the original soil surface, excavation surface, or compacted embankment surface [6].

2. Support Layer

   A layer of granular material or selected fill is used as a working floor beneath the sub-foundation to reduce the impact of weak subgrade on the pavement structure that may be found [7].

3. Upper Foundation Layer (LFA)

   The part of the structural pavement structure that is located directly below the surface is called the upper foundation layer. When not in use, the top foundation layer is built directly on the subgrade [8].

4. Asphaltic Concrete Base Course (AC Base)

   It is a hot asphalt mixture that has the lowest structural value [9].

5. Asphaltic Concrete Binder Course (AC BC)

   The pavement area is located between the surface layer and the foundation layer [9].

6. Asphaltic Concrete Wearing Course (AC WC)

   It is one of the top flexible pavement sections [9].

2.3 Planned Age

Table 1 Design Age of Road Pavement

Jenis Perkerasan	Elemen Perkerasan	Umur Rencana (Tahun)
Perkerasan Lentur	Lapisan Aspal dan Lapisan Fondasi Berbutir	20
	Lapis Fondasi Jalan	40
	Semua perkerasan untuk lokasi yang tidak dimungkinkan pelapisan ulang (*overlay*), seperti: jalan perkotaan, underpass, jembatan, dan terowongan	
	Cemen Treated Base (CTB)	
Perkerasan Kaku	Lapis fondasi atas, lapis fondasi bawah, lapis beton semen, dan fondasi jalan	
Jalan Tanpa Penutup	Semua elemen (termasuk fondasi jalan)	10

Notes :

1. If it is considered difficult to use the plan age above, a different plan age can be used, but beforehand an analysis must be carried out with *discounted life cycle costs* which can show that the plan age can provide the lowest *discounted life cycle costs*. The interest value is taken from the average interest value from Bank Indonesia, which can be obtained from official sources; And
2. The design age must take into account the road capacity.

2.4 Pavement Structure Selection

Traffic volume, design age, and condition of the road foundation will determine the type of pavement to be selected. The practicality of implementation, the life of the plan, and the lowest cost should be considered while planning it. As shown in Table 1 below, Design alternatives that can be selected based on the 2024 Road Pavement Design Manual must be based on the lowest *life cycle costs* that can be reduced.

Table 2 Selection of Pavement Type

Struktur Perkerasan	Bagan Desain	ESA5 dalam 20 tahun				
		0-1	1-4	4-10	>10-30	>30
AC modifikasi					-	2
AC dengan CTB	3, 3A, 3B	-	-	-	2	-
AC modifikasi dengan CTB					-	2
AC dengan lapis fondasi agregat	3, 3A, 3B	-	1,2	1,2	2	-
HRS tipis di atas lapis fondasi agregat	4	2	2	-	-	-
Burda atau Burtu dengan lapis fondasi agregat	5	3	3	-	-	-
AC/HRS dengan lapis fondasi *Soil Cement*	6	2	2	-	-	-
AC/HRS dengan lapis fondasi agregat dan perbaikan tanah dasar (dengan stabilisasi semen)	7	2	2	-	-	-
Perkerasan kaku dengan lalu lintas berat	8	-	-	-	2	2
Perkerasan kaku dengan lalu lintas rendah	8A	-	-	1,2	-	-
Perkerasan tanpa penutup (Japat dan jalan kerikil	9	1	-	-	-	-

For heavy patching and road widening, it is better to use the same pavement structure as the existing pavement. Special attention needs to be paid so that the water flow capabilities of the old and new granular layers are not disturbed. Because it will make work easier when maintaining the connection between flexible pavement and rigid pavement, if the flexible pavement is placed on soft ground, it is best to lay the flexible pavement in one full lane. The reconstruction plan must be integrated with the road widening schedule. The widening plan includes overlays.

2.5 Traffic Volume Analysis

The traffic data required to calculate the traffic load of a pavement plan is an important parameter in pavement structure analysis. The load is calculated from the traffic volume in the next survey year and the design life. First-year volume is defined as the traffic volume that occurs during the first year after the pavement is expected to be completed or maintained. In design, the main traffic load elements are:

a. Vehicle traffic volume per class.
b. Standard axle equivalent load (ESAL) is used to indicate the axle load of commercial vehicles.

Traffic volume analysis Depends on surveys obtained from :

a. Traffic enumeration surveys can be carried out manually using the Traffic Enumeration Survey Guidelines (Pd T-19-2004-B) or using equipment with the same approach and with a minimum survey duration of 7 times 24 hours.
b. Results from previous traffic surveys.
c. Estimated values resulting from traffic volume analysis for roads with low traffic.

There are two known types of average daily traffic calculations, namely:

1. Annual average daily traffic volume (LHRT), which is obtained from the average value of the number of vehicles for a whole year.

$$\text{LHRT} = \frac{Jumlah\ Kendaraan\ dalam\ 1\ tahun}{365} \quad (1)$$

For two-way roads without medians, LHRT is expressed in vehicles per day/2 directions or vehicles per day/2 lanes with a median.

2. Average daily traffic volume (LHR), obtained from the average value of the number of vehicles over several days of observation.

$$\text{LHRT} = \frac{Jumlah\ Kendaraan\ dalam\ 1\ tahun}{Jumlah\ hari\ pengamatan} \quad (2)$$

LHR data is quite accurate if LHR is expressed in vehicles/day/2 directions for 2-way roads without medians or vehicles/day/direction for 2-lane roads with medians while still taking into account the following factors :

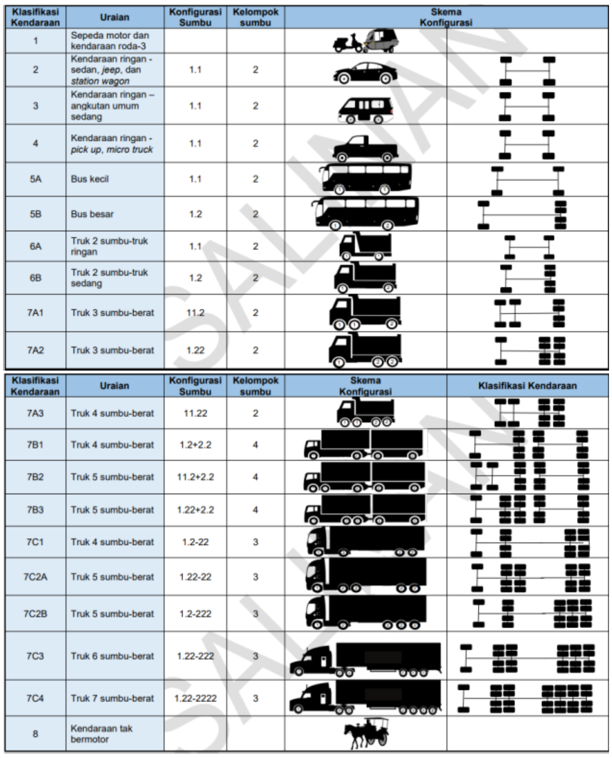
a. Observations are carried out periodically, which makes it possible to describe changes in traffic flow over a year.
b. value used in the planning process is the average value of several observations or the results of traffic studies that have been carried out.

The Indonesian Road Capacity Manual (MKJI) provides a reference for analysis of traffic volumes carried out during peak hours, and annual average daily traffic (LHRT) [11]. Traffic volume estimates must be carried out realistically. Traffic volume survey data is used to determine LHRT values. If there is any doubt about the traffic data, planners should conduct a quick survey independently to ensure that the data is correct. Otherwise, traffic data engineering should not be performed for any reason [12].

2.6 Vehicle Type

The possibility of structural damage to the pavement due to the axle load of passenger vehicles and light to medium vehicles is very small. In this analysis, only commercial vehicles with six or more wheels are taken into account. The following is Table 3 regarding the order of vehicle group types:

Table 3 Classification and Configuration of Vehicle Axles



Klasifikasi Kendaraan	Uraian	Konfigurasi Sumbu	Kelompok sumbu	Skema Konfigurasi
1	Sepeda motor dan kendaraan roda-3			
2	Kendaraan ringan - sedan, *jeep*, dan *station wagon*	1.1	2	
3	Kendaraan ringan – angkutan umum sedang	1.1	2	
4	Kendaraan ringan - *pick up, micro truck*	1.1	2	
5A	Bus kecil	1.1	2	
5B	Bus besar	1.2	2	
6A	Truk 2 sumbu-truk ringan	1.1	2	
6B	Truk 2 sumbu-truk sedang	1.2	2	
7A1	Truk 3 sumbu-berat	11.2	2	
7A2	Truk 3 sumbu-berat	1.22	2	

Klasifikasi Kendaraan	Uraian	Konfigurasi Sumbu	Kelompok sumbu	Skema Konfigurasi	Klasifikasi Kendaraan
7A3	Truk 4 sumbu-berat	11.22	2		
7B1	Truk 4 sumbu-berat	1.2+2.2	4		
7B2	Truk 5 sumbu-berat	11.2+2.2	4		
7B3	Truk 5 sumbu-berat	1.22+2.2	4		
7C1	Truk 4 sumbu-berat	1.2-22	3		
7C2A	Truk 5 sumbu-berat	1.22-22	3		
7C2B	Truk 5 sumbu-berat	1.2-222	3		
7C3	Truk 6 sumbu-berat	1.22-222	3		
7C4	Truk 7 sumbu-berat	1.22-2222	3		
8	Kendaraan tak bermotor				

2.7 Traffic Growth Factors

Traffic growth factors are calculated by making correlations with other relevant growth factors or by using a series of growth data (*historical growth data*) which can be seen in Table 4 below.

Table 4 Traffic Growth Rate Factors (***i***)(%)

Fungsi Jalan	Jawa	Sumatera	Kalimantan	Rata-rata Indonesia
Arteri dan perkotaan	4,8	4,83	5,14	4,75
Kolektor Rural	3,5	3,5	3,5	3,5
Jalan Desa	1	1	1	1

To calculate road traffic growth over the life of the plan, it can be calculated using the cumulative growth *factor* :

Spesifikasi Penyediaan Prasarana Jalan	Sumber Data Beban Gandar
Jalan Bebas Hambatan	1 atau 2
Jalan Raya	1 atau 2 atau 3
Jalan Sedang	2 atau 3
Jalan Kecil	2 atau 3

$$\boldsymbol{R} = \frac{(1+0{,}01\, i)^{UR} - 1}{0{,}01\, i} \qquad (3)$$

With

R = cumulative traffic growth multiplier factor

i = annual traffic growth rate (%)

UR = plan age (years)

2.8 Traffic on the Planned Route

The design lane is one of the traffic lanes on a road that receives the most commercial vehicle traffic, such as trucks and buses. The traffic load on the design lane is calculated by cumulative standard axle load (ESA) and direction distribution factor (DD), which usually has a value of 0.50 for two-way roads (except in certain places where the lane distribution factor/DL is greater. The lane distribution factor must come from local traffic survey data. If this data is not available, the lane distribution factor can be used in Table 5 below.

Table 5 Lane Distribution Factors (DL)

Jumlah Lajur Setiap Arah	Kendaraan Niaga pada Lajur Desain (% terhadap populasi kendaraan niaga)
1	100
2	80
3	60
4	50

On roads with two or more lanes of traffic in one direction, the lane distribution factor changes the cumulative load (CESAL). Most commercial vehicles may use the outside lane, but some may use the inside lane.

During the design life, the design load for each lane must not exceed the capacity of that lane. Lane capacity is based on Minister of Public Works Regulation No.19/PRT/M/2011[13]concerning Road Technical Requirements and Road Technical Planning Criteria, which regulates the ratio between road volume and capacity that must be met.

2.9 Load Equivalent Factor

The Equivalent Load Factor, or vehicle damage factor, is used in pavement design to convert traffic loads to standard loads (ESA). The cumulative number of ESA values on the design strip throughout the design life is used to carry out pavement structure analysis. Table 6 shows the requirements for axle load data collection.

Table 6 Axle Load Data Collection

The VDF values listed in Table 7 below can be used to calculate ESA in cases where an axle load survey is not possible or previous axle load survey data is not available.

Table 7 VDF Values for West Kalimantan Commercial Vehicle Types

Kondisi	Kelas Kendaraan	Gol 5B	Gol 6A	Gol 6B	Gol 7A1	Gol 7A2	Gol 7A3	Gol 7B1	Gol 7B2	Gol 7B3	Gol 7C1	Gol 7C2A	Gol 7C2B	Gol 7C3	Gol 7C4
VDF4	Faktual	1	1	2	-	5	-	-	-	-	3	5	4	7,6	-
	Normal	12	1	0	-	3	-	-	-	-	2	5	4	4,3	-
VDF5	Faktual	1	0	2	-	9	-	-	-	-	3	7	5	13	-
	Normal	1	0	0	-	3	-	-	-	-	3	7	5	5,9	-

2.10 Cumulative Standard Axle Load

The total amount of design traffic axle load on the design lane during the design life is called the Cumulative *Equivalent Single Axle Load* (CESAL) which is calculated as shown below:

Using VDF for all commercial vehicles

CESAL= $(\Sigma \mathrm{LHR}_{JK} \mathrm{x}\ VDF_{JK})$ x 365 x DD x DL x R (4)

CESAL = cumulative equivalent standard axle load over the design life.

LHR_{JK} = average daily traffic for each type of commercial vehicle (vehicle units per day).

VDF_{JK} = load equivalent factor (*vehicle damage factor*) for each type of commercial vehicle.

DD = direction distribution factor.

DL = lane distribution factor.

R = cumulative traffic growth multiplier factor.

2.11 Flexible Pavement Design Chart

In the road pavement planning process, Bina Marga uses the Road Pavement Design Manual Number 03/M/BM/ 20 24. The 2024 Road Pavement Design Manual is a guide for road technical planners in Indonesia. This is an update of the 2017 Road Pavement Design Manual and uses empirical mechanistic methods.

a. Flexible pavement design with 150 mm CTB (pen 60/70 and PG70 asphalt).

Table 8 Design Chart 3 (1)

	STRUKTUR PERKERASAN									
	F(1) 1	F(1) 2	F(1) 3	F(1) 4	F(1) 5	F(1) 6	F(1) 7	F(1) 8	F(1) 9	F(1) 10
	Untuk beban rencana < 30 juta ESA5 menggunakan Aspal Pen 60-70				Untuk beban rencana ≥ 30 juta ESA5 direkomendasikan menggunakan Aspal PG70(3)					
Beban rencana 20 tahun (10^6 ESA5)	> 1 - 6	> 6 - 10	> 10 - 20	>20 - 30	> 30 - 40	> 40 - 50	> 50 - 80	> 80 - 100	> 100 - 150	> 150 - 200
Jenis permukaan berpengikat	AC									
Jenis lapis fondasi	Cement Treated Base (CTB)									
Tebal Perkerasan (mm)										
AC WC	40	40	50	40	40	40	40	50	40	40
AC BC	60	75	80	65	60	60	80	80	60	60
	-	-	-	70	-	-	-	-	-	-
AC *Base* (1)	-	-	-	-	90	100	100	100	75	80
	-	-	-	-	-	-	-	-	75	90
CTB	150	150	150	150	150	150	150	150	150	150
Lapis Fondasi Agregat Kelas B	150	150	150	150	150	150	150	150	150	150
Timbunan Pilihan Berbutir Kasar atau LFA Kelas C atau Stabilisasi Semen(2)	200	200	200	200	200	200	200	200	200	200

Notes:

1. Especially for AC Bases with planned traffic above 30 million ESA5, you can not use PG70 asphalt.
2. Can use selected coarse-grained fill that has a minimum CBR of 30% with a PI of 6-15 and a maximum grain size of 50 mm or LFA Class C or cement stabilization (UCS 10 kg/m2). If the three types of materials or tools required for stabilization are not found, then this layer can be replaced with Class B LFA with a thickness of 200 mm if the price is the same or lower than the three materials.
3. Especially for AC WC and AC BC.

b. Flexible pavement design with 200 mm CTB (pen 60/70 and PG70 asphalt).

Table 9 Design Chart 3 (2)

	STRUKTUR PERKERASAN							
	F(2) 1	F(2) 2	F(2) 3	F(2) 4	F(2) 5	F(2) 6	F(2) 7	F(2) 8
	Untuk beban rencana < 30 juta ESA5 menggunakan Aspal Pen 60-70			Untuk beban rencana ≥ 30 juta ESA5 direkomendasikan menggunakan Aspal PG70(3)				
Beban rencana 20 tahun (10^6 ESA5)	> 1 - 8	> 8 - 15	> 15 - 30	> 30 - 50	> 50 - 75	> 75 - 95	> 95 - 150	> 150 - 200
Jenis permukaan berpengikat	AC							
Jenis lapis fondasi	Cement Treated Base (CTB)							
Tebal Perkerasan (mm)								
AC WC	40	50	50	40	40	40	50	40
AC BC	60	70	80	70	60	70	80	60
	-	-	-	70	-	-	-	-
AC *Base* (1)	-	-	-	-	100	100	100	75
	-	-	-	-	-	-	-	75
CTB	200	200	200	200	200	200	200	200
Lapis Fondasi Agregat Kelas B	150	150	150	150	150	150	150	150
Timbunan Pilihan Berbutir Kasar atau LFA Kelas C atau Stabilisasi Semen(2)	200	200	200	200	200	200	200	200

Notes:

1. Especially for AC Bases with planned traffic above 30 million ESA5, you can not use PG70 asphalt.
2. Can use selected coarse-grained fill that has a minimum CBR of 30% with a PI of 6-15 and a maximum grain size of 50 mm or LFA Class C or cement stabilization (UCS 10 kg/m2). If the three types of materials or tools required for stabilization are not met, then this layer can be replaced with LFA Class B with a thickness of 200 mm if the price is the same or lower than the three materials.
3. Especially for AC WC and AC BC.

c. Flexible pavement design with 250 mm CTB (pen 60/70 and PG70 asphalt).

Table 10 Design Chart 3 (3)

	STRUKTUR PERKERASAN						
	F(3) 1	F(3) 2	F(3) 3	F(3) 4	F(3) 5	F(3) 6	F(3) 7
	Untuk beban rencana < 30 juta ESA5 menggunakan Aspal Pen 60-70			Untuk beban rencana ≥ 30 juta ESA5 direkomendasikan menggunakan Aspal PG70(3)			
Beban rencana 20 tahun (10^6 ESA5)	> 1 - 9	> 9 -15	> 15 - 30	> 30 - 50	> 50 - 75	> 75 - 110	> 110 - 200
Jenis permukaan berpengikat	AC						
Jenis lapis fondasi	Cement Treated Base (CTB)						
Tebal Perkerasan (mm)							
AC WC	40	40	50	40	40	40	40
AC BC	60	70	80	60	70	65	80
	-	-	-	70	-	-	-
AC *Base* (1)	-	-	-	-	80	100	100
	-	-	-	-	-	-	-
CTB	250	250	250	250	250	250	250
Lapis Fondasi Agregat Kelas B	150	150	150	150	150	150	150
Timbunan Pilihan Berbutir Kasar atau LFA Kelas C atau Stabilisasi Semen(2)	200	200	200	200	200	200	200

d. Flexible pavement design with 300 mm CTB (pen 60/70 and PG70 asphalt).

Table 11 Design Chart 3 (4)

	STRUKTUR PERKERASAN							
	F(4) 1	F(4) 2	F(4) 3	F(4) 4	F(4) 5	F(4) 6	F(4) 7	F(4) 8
	Untuk beban rencana < 30 juta ESA5 menggunakan Aspal Pen 60-70			Untuk beban rencana ≥ 30 juta ESA5 direkomendasikan menggunakan Aspal PG70(3)				
Beban rencana 20 tahun (10^6 ESA5)	> 1 - 10	> 10 - 17	>17 - 30	> 30 - 40	>40 - 60	>60 - 90	>90 - 150	>150 - 200
Jenis permukaan berpengikat	AC							
Jenis lapis fondasi	Cement Treated Base (CTB)							
Tebal Perkerasan (mm)								
AC WC	40	40	50	50	40	50	50	50
AC BC	60	70	75	80	60	60	60	75
	-	-	-	-	70	-	-	-
AC *Base* (1)	-	-	-	-	-	80	100	100
	-	-	-	-	-	-	-	-
CTB	300	300	300	300	300	300	300	300
Lapis Fondasi Agregat Kelas B	150	150	150	150	150	150	150	150
Timbunan Pilihan Berbutir Kasar atau LFA Kelas C atau Stabilisasi Semen(2)	200	200	200	200	200	200	200	200

e. Flexible-asphalt pavement using an aggregate base layer (pen 60/70 and PG70 asphalt).

Table 12 Design Chart 3A

	STRUKTUR PERKERASAN								
	FFF(1) 1	FFF(1) 2	FFF(1) 3	FFF(1) 4	FFF(1) 5	FFF(1) 6	FFF(1) 7	FFF(1) 8	FFF(1) 9
	Untuk beban rencana < 30 juta ESA5 menggunakan Aspal Pen 60-70					Untuk beban rencana ≥ 30 juta ESA5 direkomendasikan menggunakan Aspal PG70[1]			
Beban rencana 20 tahun (10^6 ESA5)	< 2	> 2 - 5	> 5 - 10	> 10 - 15	> 15 - 30	> 30 - 50	> 50 - 100	> 100 - 150	> 150 - 200
Tebal Perkerasan (mm)									
AC WC	60[2]	40	40	40	40	40	40	50	40
AC BC	-	65	75	75	60	60	75	80	60
	-	80	80	-	-	-	-	-	-
AC *Base* [3]	-	-	-	100	80	85	100	100	80
	-	-	-	-	80	100	100	100	80
	-	-	-	-	-	-	-	-	90
Lapis Fondasi Agregat Kelas A[4]	200	200	200	200	200	200	200	200	200
Lapis Fondasi Agregat Kelas B	150	150	150	150	150	150	150	150	150
Timbunan Pilihan Berbutir Kasar atau LFA Kelas C atau Stabilisasi Semen[5]	-	-	200	200	200	200	200	200	200

f. Adjustment of the thickness of selected coarse-grained fill layer or LFA Class C or cement stabilization (only for design chart 3A) 20-year design load > 5 million ESA5.

Table 13 Design Chart 3B

		Tebal (mm)
Subgrade 6 < CBR < 10	Timbunan Pilihan Berbutir Kasar atau LFA Kelas C atau Stabilisasi Semen	200
Subgrade 10 ≤ CBR < 30	Timbunan Pilihan Berbutir Kasar atau LFA Kelas C atau Stabilisasi Semen	150
Subgrade CBR ≥ 30	Timbunan Pilihan Berbutir Kasar atau LFA Kelas C atau Stabilisasi Semen	-

Source: General Directorate of Highways, 2024

g. Flexible pavement design using HRS.

Table 14 Design Chart 4

Kumulatif beban sumbu 20 tahun pada lajur rencana (10^6 CESA5)	FF1 < 0,5	0,5 ≤ FF2 ≤ 4,0
Jenis permukaan	HRS atau Penetrasi Makadam	HRS[2]
Struktur perkerasan	Tebal lapisan (mm)	
HRS-WC	50	30
HRS-*Base*	-	35
LFA Kelas A	150	250
LFA Kelas B atau kerikil alam atau lapis distabilisasi dengan CBR > 10% [3]	150	150

h. Granulated layer pavement with coating.

Table 15 Design Chart 5

	STRUKTUR PERKERASAN		
	SD1	SD2	SD3
	Kumulatif Beban Rencana (ESA4x10^6)		
	< 0,1	0,1 - 0,5	> 0,5 - 4
Burda			
Lapis Fondasi Agregat Kelas A[2]	200	250	300
Lapis Fondasi Agregat Kelas B, atau kerikil alam, atau stabilisasi dengan CBR > 10%, pada *subgrade* dengan CBR ≥ 5% [2,5]	100	110	140

i. Pavement design with soil cement stabilization for areas with low amounts of aggregate or gravel.

Table 16 Design Chart 6

	STRUKTUR PERKERASAN[1]		
	SC1	SC2	SC3
	Beban Sumbu 20 tahun pada lajur desain (ESA4 x 10^6)		
	< 0,1	0,1- 0,5	> 0,5 – 4
	Ketebalan lapis perkerasan (mm)		
HRS WC, AC WC	50*		
Lapis Fondasi Tanah Semen Target UCS 2,4 MPa	160	220	300

j. Pavement design with improved cement stabilization subgrade in areas with low sources of aggregate or gravel.

Table 17 Design Chart 7

	STRUKTUR PERKERASAN[1]		
	SC1	SC2	SC3
	Beban Sumbu 20 tahun pada lajur desain (ESA4 x 10^6)		
	< 0,1	0,1- 0,5	> 0,5 – 4
	Ketebalan lapis perkerasan (mm)		
HRS WC, AC WC	50*		
Lapis Fondasi Agregat Kelas A	160	220	300
Lapis Fondasi Agregat Kelas B	110	150	200
Stabilisasi tanah asli hingga mencapai CBR ekuivalen 6%	160	200	260

Notes:

1. Design Chart 7 is used for all subgrade soils with a CBR of more than 2.5%. The provisions of Design Chart 2 remain applicable for subgrade soil with a CBR of less than 2.5%.
2. Stabilization of the original soil is required to obtain a design CBR equivalent to a CBR of at least 6%, using the following criteria approach:

in-situ subgrade to the selected or stabilized subgrade using an equation identical to the equation as follows:

$$CBR_{is} = CBR_{ti} \times 2^{(\text{thickness of selected or stabilized material layer(mm)}/150)} \quad (5)$$

Information,

CBR_{is}: CBR *improvement subgrade*

CBR_{ti}: CBR of *in-situ soil*

3. With adequate stabilization equipment and compaction with *a pad-foot roller* with a static weight of at least 18 tons, stabilization of a single layer with a thickness of more than 200 mm to 300 mm is permitted.

Burda or stabilization work can only be carried out by a high-quality contractor with adequate equipment.

2.12 Budget plan

The amount of costs required is calculated in calculating the amount of budget requirements for a job. A cost budget plan is also needed in selecting materials of good quality according to the planned work. The cost budget plan contains the types of work items arranged based on the type of construction project being planned. In planning to improve airport road access, budget planning is used to identify the costs required by taking into account the volume of work planned.

In calculating the budget plan for improving road access, this time we will use an analysis of the cost of work units following Ministerial Regulation No. 78 of 2014 [14] and Standard Unit Prices for Goods Needed by the Ketapang Regency Government for the 2024 Fiscal Year [15].

3. RESEARCH RESULTS

3.1 Traffic Data

Daily traffic data on the Rahadi Oesman Ketapang airport road access was obtained after conducting a manual survey over 7x24 hours but adjusted to the airport's operational hours. The survey results can be seen in Table 9 below:

Table 18 Data from Daily Traffic Survey Results

Gol	Jenis Kendaraan	Hari 1	Hari 2	Hari 3	Hari 4	Hari 5	Hari 6	Hari 7
1	Sepeda Motor	448	401	343	325	364	384	412
2	Sedan, Jeep dan Station Wagon	28	25	28	31	49	41	54
3	Oplet, Pick Up dan Minibus	310	280	142	130	164	191	244
4	Micro Truck dan Mobil Hantaran	40	20	14	15	15	12	11
5a	Bus Kecil	49	24	9	5	12	12	7
5b	Bus Besar	3	1	8	4	2	6	2
6a	Truck Ringan 2 Sumbu	9	5	6	5	7	4	6
6b	Truck Sedang 2 Sumbu	6	8	5	7	7	9	7

3.2 Cumulative Standard Axle Load

Before determining the cumulative standard load equivalent to the design life, several things must be done, namely:

1. Determining the VDF (*Vehicle Damage Factor) Value*

   In determining the VDF (*Vehicle Damage Factor*) value, can be seen in Table 7 by adjusting the type of commercial vehicle according to the Kalimantan region. According to the results of the survey that has been carried out, commercial vehicles that cross the planned access road are listed as only vehicles for categories 5a, 5b, 6a, and 6b as in Table 10 below:

Table 19 Commercial Vehicle VDF Value

Jenis Kendaraan	Beban Aktual		Normal	
	VDF 4	VDF 5	VDF 4	VDF 5
5a	-	-	-	-
5b	1,0	1,0	1,0	1,0
6a	0,55	0,5	0,55	0,5
6b	4,8	8,5	3,4	4,7

2. Determining Lane Distribution Factor (DL)

   The lane distribution factor is obtained from Table 5 by looking at the number of lanes in each direction and the percentage of commercial vehicles crossing the design lane. The Rahadi Oesman Airport access road currently has 1 lane in each direction with 100% of commercial vehicles passing through the design lane. So, the DL value is 1.

3. Determining Directional Distribution Factor (DD)

   For two-way roads, according to the General Directorate of Highways, 2024, the directional distribution factor (DD) is generally taken to be 0.50, except in locations where the number of commercial vehicles tends to be fewer.

4. Calculating Traffic Growth Factors

   Calculating the traffic growth factor with the value (*i*) obtained according to table 2.3, namely 3.5% with the calculation according to table 4 is as follows:

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

   $$\boldsymbol{R} = \frac{(\mathbf{1+0{,}01}\ \boldsymbol{x}\ \mathbf{0{,}035})^{\mathbf{20}}\mathbf{-1}}{\mathbf{0{,}01}\ \boldsymbol{x}\ \mathbf{0{,}035}}$$

   R= 20,066

5. Calculating Cumulative Standard Axle Load

   The ESA calculation according to the type of vehicle along with the VDF 4 and VDF 5 values has been calculated in the table below with formula 4 as follows,

Table 20 Cumulative Estimates of CESA4 and CESA5 Traffic Loads

Gol Kend	LHR 2023	LHR 2043	VDF4		VDF5		DD	DL	R	CESA4		CESA5	
			Faktual	Normal	Faktual	Normal			(i=3,5%)	Faktual	Normal	Faktual	Normal
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
1	382	385	0	0	0	0	0,5	1	20,066	0	0	0	0
2	36	36	0	0	0	0	0,5	1	20,066	0	0	0	0
3	209	210	0	0	0	0	0,5	1	20,066	0	0	0	0
4	18	18	0	0	0	0	0,5	1	20,066	0	0	0	0
5A	17	17	0	0	0	0	0,5	1	20,066	0	0	0	0
5B	4	4	1,2	1,2	1,3	1,3	0,5	1	20,066	16.437	16.437	17.807	17.807
6A	6	6	0,5	0,5	0,4	0,4	0,5	1	20,066	11.063	1.831	8.851	8.851
6B	7	7	3,8	0,8	5,5	0,7	0,5	1	20,066	98.095	20.651	141.979	18.070
									Jumlah ESA	125.595	38.919	168.636	44.727
									ESA	164.514		213.364	
										CESA4		CESA5	

Formula description for each column:

CESAL = (ΣLHR $_{JK}$ x VDF $_{JK}$) x 365 x DD x DL x R

(11) = (3) x (4) x 365 x (8) x (9) x (10)

(12) = (3) x (5) x 365 x (8) x (9) x (10)

(13) = (3) x (4) x 365 x (8) x (9) x (10)

(14) = (3) x (5) x 365 x (8) x (9) x (10)

3.3 Determination of Pavement Thickness

After calculating the design life and cumulative standard axle load according to the type of vehicle, the total CESA4 value is 164,514 and the CESA5 value is 213,364. From the CESA4 and CESA5 values obtained, it is then adjusted to select the type of pavement referring to Table 3 for ESA5 values of 0-1 million using pavement design charts 4, 5, 6, 7, and design chart 9.

However, when widening the road, the type of pavement chosen is the same as the existing pavement, namely *flexible pavement* or asphalt, so design chart 7 is used as a reference with the SC2 category because the ESA4 value is > 0.1-0.5 million. This can be seen in table 17 below,

Table 21 Design Chart 7

	STRUKTUR PERKERASAN[1]		
	SC1	SC2	SC3
	Beban Sumbu 20 tahun pada lajur desain ($ESA4 \times 10^6$)		
	< 0,1	0,1- 0,5	> 0,5 – 4
	Ketebalan lapis perkerasan (mm)		
HRS WC, AC WC		50*	
Lapis Fondasi Agregat Kelas A	160	220	300
Lapis Fondasi Agregat Kelas B	110	150	200
Stabilisasi tanah asli hingga mencapai CBR ekuivalen 6%	160	200	260

3.4 Road Pavement Design

The choice of pavement structure for widening the access road to Rahadi Oesman Ketapang Airport follows the condition and type of existing pavement by processing data regarding traffic conditions and design age.

For the design of the pavement structure for the Rahadi Oesman Ketapang airport road access with traffic conditions of 164,514 for the CESA4 value and 213,364 for the CESA5 value. Therefore, based on the 7-column SC2 design chart, the arrangement of pavement layer thickness and cross section for road widening is obtained as shown in Figures 2 and 3 below:

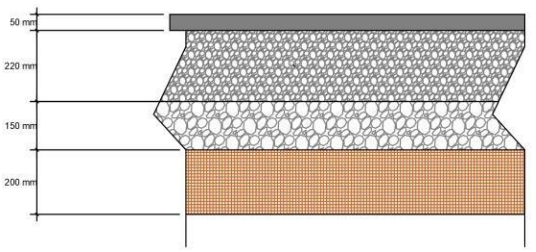


Figure 2 Results of Pavement Layer Thickness

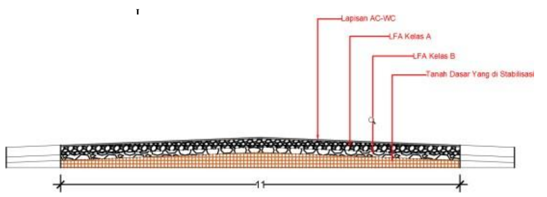


Figure 3 Cross section of the road

3.5 Basic Land CBR

The CBR data for the subgrade at the Rahadi Oesman Ketapang Airport RTT is 12%, so to calculate the subgrade stabilization value using the formula stated in equation 5 is as follows:

$$\text{CBR value}_{is} = \text{CBR}_{ti} \times 2^{(\text{thickness of selected or stabilized material layer}/150)}$$

$$\text{CBR value}_{is} = 12 \times 2^{(200/150)}$$

$$\text{CBR value} = 30.23\%$$

Later the stabilization CBR value used to design the base soil stabilization layer on flexible pavement is following Table 8 Design Chart 7 of the 2024 Road Pavement Design Manual, namely 30.23%.

3.6 Road Class Classification

After planning the widening of the access road to Rahadi Oesman Ketapang Airport by carrying out calculations using the 2024 Road Pavement Design Manual method, we obtained a road with 2 lanes, 1 lane in 2 directions with a total road width of 11 meters using flexible pavement.

Referring to PU Ministerial Decree No. 19 of 2011 concerning Road Technical Requirements and Road Technical Planning Criteria Article 48, the Rahadi Oesman Ketapang Airport access road according to its planned use becomes a class II road which can be used by vehicles with the heaviest axle load of 8 tons, 12 meters long, 4.2 meters high, and 2.5 meters wide.

3.7 Calculating the Cost Budget Plan

The budget plan for expenditure is a calculation for the budget carried out using unit work cost analysis which is explained by multiplying the price of materials, wages, and equipment by the need for materials, wages, and equipment following standard worker salaries and equipment rental/purchase costs based on PM 78 2014 and Standard Unit Price of Goods for Ketapang Regency in 2024.

Table 22 Calculation of Cost Budget Plan

RENCANA ANGGARAN BIAYA
(RAB)

NO	URAIAN JENIS PEKERJAAN	SATUAN	Rincian Perhitungan		Harga Satuan (Rp)	Jumlah Harga (Rp)
			Panjang x Lebar x Tinggi x Unit	Jumlah		
1	2	3	4	5	6	7
	PEKERJAAN PERSIAPAN					
						Rp 65.680.922,50
	PEKERJAAN TANAH					
						Rp 101.285.132,60
	PEKERJAAN LAPISAN PERKERASAN					
						Rp 306.511.276,88

Table 23 Results of Budget Plan Recapitulation

REKAPITULASI
RENCANA ANGGARAN BIAYA

Keluaran (output)	:	Pekerjaan Peningkatan Akses Jalan
Volume	:	835
Satuan Ukur	:	m2
Lokasi	:	Bandar Udara Rahadi Oesman-Ketapang

NO	URAIAN JENIS PEKERJAAN	JUMLAH HARGA
I	PEKERJAAN PERSIAPAN	Rp 65.680.922,50
II	PEKERJAAN TANAH	Rp 101.285.132,60
III	PEKERJAAN LAPISAN PERKERASAN	Rp 306.511.276,88
	JUMLAH	Rp 473.477.331,98
	PPN 11%	Rp 52.082.506,52
	TOTAL	Rp 525.559.838,50
	DIBULATKAN	**Rp 525.560.000,00**

TERBILANG : LIMA RATUS DUA PULUH LIMA JUTA LIMA RATUS ENAM PULUH RIBU RUPIAH

4. CONCLUSIONS AND SUGGESTIONS

4.1 Conclusion

Daily traffic data on the Rahadi Oesman Ketapang airport road access was obtained after conducting a manual survey over 7x24 hours but adjusted to the airport's operational hours. The survey results can be seen in Table 9 below: In the discussion regarding the stages in planning to improve the road class on the Rahadi Oesman-Ketapang Airport access road which includes calculating the thickness of the pavement for widening the road using the work implementation method using the 2024 Road Pavement Design Manual, the author can conclude.

1. The classification of the Rahadi Oesman Ketapang Airport road access, which was originally a class III road type, has been increased to a class II road type which has 2 lanes and 1 road lane with a total width of 11 meters and can withstand the heaviest axle of 8 tons.
2. Based on LHR data calculations, the CESA4 value is 164,514 and the planned age is 20 years. From the values obtained, it is known that the CESA4 value is between 0.1-0.5 million, the AC / HRS type of pavement is planned with an aggregate foundation layer and subgrade improvement (with cement stabilization). Design Chart 7 of the 2024 Road Pavement Design Manual was used as a basis for determining the thickness of the pavement and obtained a road pavement structure with a thickness of AC-WC=50 mm, LFA Class A=220 mm, LFA Class B=150mm, and original soil stabilization=200 mm.
3. Based on budget calculations, improving the road class on the Rahadi Oesman-Ketapang Airport access road requires funds of IDR 525,560,000.00 (Five Hundred Twenty-Five Million Five Hundred and Sixty Thousand Rupiah).

Suggestion

Based on the results of the discussion and planning for improving the road class on the Rahadi Oesman-Ketapang Airport access road, several suggestions can be considered, namely:

1. It is recommended that Rahadi Oesman Airport implement an increase in road class on the Rahadi Oesman Airport-Ketapang access road to support optimal facilities and services.
2. If there are regulations regarding the latest guidelines or references for the methods used, it is best to adapt them to the latest regulations or guidelines.
3. In future research, it is hoped that the writing of this research can be used as a reference so that it becomes research that is more perfect than previous research.

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