PAVEMENT CONSTRUCTION PLANNING OF ACCESS ROAD AT JENDERAL AHMAD YANI INTERNATIONAL AIRPORT SEMARANG

Achmad Rafi Aditya[1*] , Wiwid Suryono[2] , Fahrur Rozi[3]

[1,2,3)]Politeknik Penerbangan Surabaya, Jemur Andayani I/73 Wonocolo Surabaya, East Java, Indonesia, 60236
**Corresponding Author Email: achmadrafiaditya@gmail.com*

ABSTRACT

Jenderal Ahmad Yani International Airport is an airport located in Semarang, Central Java Province. The airport requires adequate access road infrastructure to support the operational performance of the Airport Rescue and Fire Fighting (ARFF) unit in emergency situations. Currently, the airport does not yet have a proper access road that meets aviation safety standards, which may hinder emergency response. Therefore, further planning is needed in the form of access road construction to improve response effectiveness and ensure flight safety. This study aims to determine the design and cost requirements for the ARFF access road at Jenderal Ahmad Yani International Airport. This study uses a quantitative method with a civil engineering planning approach, applying the 1987 Bina Marga Component Analysis Method. In this study, several stages were carried out. The stages include field measurement, documentation, literature review, pavement design based on SKEP/347/XII/1999, and calculating the Draft Budget Cost for the access road construction. The results of this study show that the planned access road has dimensions of 400 m in length, 7.2 m in width, and a 25 m turning radius, with a pavement structure of 40 cm consisting of a 5 cm LASBUTAG MS454 surface layer, a 15 cm Class A crushed stone base course, and a 20 cm Class A sand and gravel subbase course adjusted to the local subgrade CBR value. Based on the Cost Budget Plan that has been made, the construction cost is IDR 3,321,045,000.00 (three billion three hundred twenty-one million forty-five thousand rupiah).

Keywords: *Access Road, Component Analysis, Aviation Safety, Pavement, Response Time.*

INTRODUCTION

Jenderal Ahmad Yani International Airport Semarang (ICAO: WAHS, IATA: SRG) is located 3.65 km from the center of Semarang City, Central Java. The airport has a runway measuring 2,560 m × 45 m with flexible asphalt pavement (PCN 61 F/D/X/T), two taxiways—Golf and Foxtrot (261.5 m × 23 m, PCN 79 F/C/X/T), and an apron measuring 551.5 m × 131.5 m (PCN 70 R/D/X/T) with a capacity of 12 parking stands.

Jenderal Ahmad Yani International Airport Semarang plays a strategic role in supporting economic growth, trade, and the tourism sector in Central Java. Along with the increasing intensity of aircraft operations, the national aviation industry—particularly the aviation sector in Indonesia—has shown rapid growth [1]. Therefore, various development efforts have been undertaken to enhance the capacity and service quality of this airport. These developments are intended to support the increase in air traffic and accommodate the expansion of the aviation industry in the future.

Aviation safety is a top priority that cannot be compromised, regardless of airport size or the density of air traffic [2]. In this context, aircraft rescue and fire-fighting services are vital components regulated under the Directorate General of Civil Aviation Regulation PR 30 of 2022.

The Aircraft Rescue and Fire Fighting (ARFF) unit is responsible for handling emergencies at the airport by applying competent technical standards and implementing operational measures in accordance with prevailing regulations. The primary duty of this unit is to respond to aviation incidents and emergency situations occurring within the airport vicinity [3]. Based on observations conducted in the ARFF unit, it was found that dedicated access roads for ARFF vehicles are not yet available and do not comply with civil aviation safety standards as stipulated in Directorate General of Civil Aviation Regulation PR 30 of 2022.

Currently, ARFF vehicles rely on aprons and taxiways as emergency routes, which are highly limited since they must share space with aircraft movements and other operational vehicles in the airside area. This condition poses a high potential risk to personnel safety, especially when rapid maneuvers and lane changes are required during emergencies. Physical obstacles within the movement area, such as non-optimal turning radii and obstructions, further exacerbate delays in response times. Moreover, the absence of a dedicated priority route hampers the effectiveness of rescue units in reaching emergency locations swiftly and safely. Thus, the existing conditions indicate the urgent need for planning an access road that meets geometric design standards, load-bearing capacity, and response-time efficiency in line with both national and international emergency response standards.

The planning of access roads must refer to various regulations and technical documents that establish aviation safety standards at both national and international levels. The Directorate General of Civil Aviation Regulation PR 30 of 2022 emphasizes that ARFF units must be equipped with supporting facilities, including access roads that enable rescue vehicles to move quickly, safely, and without obstruction toward emergency sites. This requirement is consistent with technical guidelines in SKEP/347/XII/1999 and the global standards set by ICAO Annex 14, which mandate the availability of emergency routes with a maximum response time of two to three minutes from the ARFF station to the incident site.

However, when compared to actual airport conditions, a gap is evident between regulatory requirements and on-site implementation. Observations reveal that to date, a dedicated access road that meets ARFF operational standards has not yet been constructed. Rescue vehicles still rely on aprons and taxiways, routes that were not designed for emergency response and that must share traffic with aircraft and other vehicles. These conditions result in restricted access and delays in response times during emergencies. Non-compliant turning radii, insufficient signage, and the presence of obstacles in the movement area further increase operational risks. Such discrepancies highlight the urgent necessity for access road planning in accordance with regulations, ensuring that aviation safety standards are realized not only as written guidelines but also as tangible infrastructure that supports optimal emergency preparedness.

As part of the planning effort, field data collection will be carried out directly in the airport's airside area. The data will include measurements of the length, width, and turning radii of the existing routes currently used by ARFF vehicles. These measurements will serve as the basis for designing the access road, as well as determining pavement structures capable of withstanding the load of ARFF vehicles.

According to ICAO standards, the maximum allowable response time is three minutes under optimal conditions. If the actual travel time exceeds this threshold, the airport is deemed non-compliant with aviation safety standards and must promptly address the issue through the development of improved supporting infrastructure. Other risks analyzed include potential collisions with aircraft or other vehicles due to improper route crossings, as well as limited maneuvering space for ARFF vehicles in narrow areas not designed for emergency traffic.

Challenges in maintaining aviation safety, such as aborted landings, take-off failures, and fire incidents, demand rapid and precise responses [4]. The absence of access roads poses a significant risk to operational safety, as ARFF vehicles are forced to use non-standard routes that may delay response times and endanger personnel. Therefore, the ARFF unit must be equipped with adequate facilities, including a structurally strong access road with a minimum width of 5 meters and a minimum turning radius of 25 meters. This road should also be designed to enable vehicles to move directly from the fire station to the runway within the optimal response time. According to the Directorate General of Civil Aviation Decree of 2015 and Regulation PR 30 of 2022, every airport is required to provide access roads as vital infrastructure to support the effectiveness of emergency operations.

METHOD

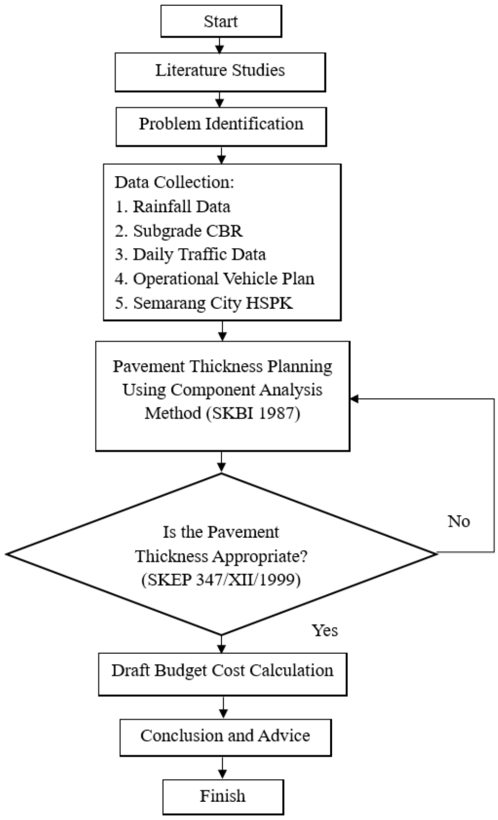

Figure 1 Research Flow Chart

Data Collection

In this study was carried out using both quantitative and qualitative approaches. Quantitative data consisted of primary data obtained through direct field observations to gather information on the length, width, and topographic conditions of the planned access road, as well as secondary data collected from relevant agencies in the form of soil CBR values, rainfall data, and operational vehicle plans sourced from official documents and historical reports. Meanwhile, qualitative data were obtained through direct observations at Jenderal Ahmad Yani International Airport, particularly in the ARFF unit, which revealed a lack of facilities in the form of access roads, and through documentation in the form of photographs of field conditions to strengthen the findings and provide a clearer description of the actual situation.

Pavement Thickness Planning Using Component Analysis Method (SKBI 1987)

The component analysis method is one of the approaches used in designing pavement structures. This method can be applied to new pavement construction, rehabilitation of existing pavement, as well as staged construction. The calculation of pavement thickness using the component analysis method is outlined in SKBI-2.3.26.1987, as stated in the Guidelines for Flexible Pavement Thickness Design on Highways using the Component Analysis Method.

In pavement design with the component analysis method, several aspects need to be taken into consideration:

1. The Design Vehicle

   The design vehicle is adjusted to the size and maneuvering radius of the vehicle.

2. Number of Lanes and Vehicle Distribution Coefficient (C)

   The planned lane is part of the traffic system designed to accommodate the largest vehicle dimensions [5]. If the lane is not yet equipped with boundary markings, its determination can refer to the following table:

   Table 1 Number of Lanes Based on Pavement Width

Pavement width (L)	Number of lanes (n)
L < 5,50 m	1 lane
5,50 m ≤ L < 8,25 m	2 lanes
8,25 m ≤ L < 11,25 m	3 lanes
11,25 m ≤ L < 15,00 m	4 lanes
15,00 m ≤ L < 18,75 m	5 lanes
18,75 m ≤ L < 22,00 m	6 lanes

   The vehicle distribution coefficient (C) for light and heavy vehicles passing through the planned lane is determined according to the table below:

   Table 2 Vehicle Distribution Coefficient

Number of lanes	Light Vehicles*)		Heavy Vehicles**)	
	One-way	Two-way	One-way	Two-way
1 lane	1,00	1,00	1,00	1,000
2 lanes	0,60	0,50	0,70	0,500
3 lanes	0,40	0,40	0,50	0,475
4 lanes	-	0,30	-	0,450
5 lanes	-	0,25	-	0,425
6 lanes	-	0,20	-	0,400

   *) total weight < 5 tons, for example passenger cars, pick-up trucks, delivery vehicles

   **) total weight > 5 tons, for example buses, trucks, tractors, semi-trailers, trailers

3. Average Daily Traffic (ADT)

   The Average Daily Traffic (ADT) for each type of vehicle is determined at the beginning of the design period, calculated for two-way traffic on roads without a median, or for each direction on roads with a median.

   $LHR_{(\text{beginning/endDL})} = \sum LHRj(data) x(1+1)^n$

   Notes:

   ADT = Average Daily Traffic volume

   J = Vehicle type

   n = Planned road service life/construction ………………period

   i = Traffic growth factor

   DL = Design Life

4. Equivalent Factor (E) of Vehicle Axle Load

   The Equivalent Factor (E) is a value that indicates the level of pavement damage caused by each vehicle axle load, calculated based on the axle load category according to the prescribed formulas or tables.

   Table 3 Equivalent Factor (E) of Vehicle Axle Load

Axle Load		Equivalent Factor	
Kg	Lb	Single Axle	Double Axle
1000	2205	0,0002	-
2000	4409	0,0036	0,0003
3000	6614	0,0183	0,0016
4000	8818	0,0577	0,0050
5000	11023	0,1410	0,0121
6000	13228	0,2923	0,0251
7000	15432	0,5415	0,0466
8000	17637	0,9238	0,0794
8160	18000	1,0000	0,0860
9000	19841	1,4798	0,1273
10000	22046	2,2555	0,1940
11000	24251	3,3022	0,2840
12000	26455	4,6770	0,4022
13000	28660	6,4419	0,5540
14000	30864	8,6647	0,7452
15000	33069	11,4184	0,9820
16000	35276	14,7815	1,2712

5. Initial Equivalent Traffic (IET)

   The Initial Equivalent Traffic is the total equivalent traffic at the beginning of the design period or when the road starts operating. The calculation of LEP is carried out using the following formula:

   $\sum_{j=1}^{n} \quad LHR_j x C_j x E_j$

   Note:

   j = vehicle type

6. Mid Equivalent Traffic (MET)

   The Mid Equivalent Traffic is the average equivalent traffic during the design period. It is calculated using the formula:

   $MET = \frac{1}{2} x(IET + FET)$

7. Final Equivalent Traffic (FET)

   The Final Equivalent Traffic is the estimated total equivalent traffic at the end of the design period. The calculation of FET is as follows:

   $FET = \sum_{j=1}^{n} \quad LHR_j(1+i)^{DL} \times C_j x E_j$

8. Design Equivalent Traffic (DET)

   The Design Equivalent Traffic is the total equivalent traffic used in pavement design. It is calculated using the formula:

   DET = MET x AF

   The adjustment factor (AF) is determined using the formula:

   $\text{AF} = \frac{DL}{10}$

9. Subgrade Bearing Capacity (SBC)

The Subgrade Bearing Capacity (SBC) is a parameter on the nomogram used to determine pavement thickness based on the strength of the subgrade. SBC represents the soil's ability to withstand pressure and the maximum load that can be supported by the foundation [6]. It significantly affects the performance of the layers above it. Determining the SBC value requires California Bearing Ratio (CBR) test data of the soil [7].

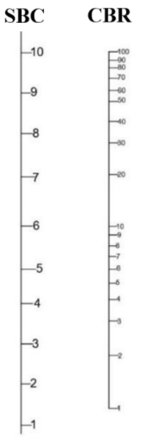

Figure 2 Correlation Between SBC and CBR

10. Regional Factor (RF)

The regional factor is influenced by field conditions, climate, soil bearing capacity (SBC), and the pavement itself [8].

Table 4 Regional Factor

	Gradient I (< 6 %)		Gradient II (6 – 10 %)		Gradient III (> 10%)	
	% Vehicle Weight					
	≤ 30 %	> 30 %	≤ 30 %	> 30 %	≤ 30 %	> 30 %
Climate I < 900 mm/year	0,5	1,0 – 1,5	1	1,5 – 2,0	1,5	2,0 – 2,5
Climate II > 900 mm/year	1,5	2,0 – 2,5	2	2,5 – 3,0	2,5	3,0 – 3,5

Note:

The Regional Factor (RF) shall be adjusted by +0.5 at intersections, stops, or sharp curves (r = 30 m), and by +1.0 in swamp areas.

11. The Surface Index (SI)

The surface index affects the level of service for passing traffic; therefore, factors such as smoothness, evenness, and surface strength must be considered. Measurement of the surface index is based on road serviceability, observed through damage such as cracks, ruts, and potholes [9].

Surface Index Categories:

SI = 1.0 : Severely damaged road surface condition that disrupts traffic flow.

SI = 1.5 : Lowest service level, but the road remains passable.

SI = 2.0 : Low service level with the road still in good condition.

SI = 2.5 : Road surface in good and stable condition.

Table 5 Surface Index at the Beginning of the Design Life (SI)

Surface Type	SI	Roughness *) (mm/km)
LASTON	≥ 4	≤ 1000
	3,9 – 3,5	> 1000
LASBUTAG	3,9 – 3,5	≤ 2000
	3,4 – 3,0	> 2000
HRA	3,9 – 3,5	≤ 2000
	3,4 – 3,0	> `2000
BURDA	3,9 – 3,5	< 2000
BURTU	3,4 – 3,0	< 2000
LAPEN	3,4 – 3,0	≤ 3000
	2,9 – 2,5	> 3000
LATASBUM	2,9 – 2,5	
BURAS	2,9 – 2,5	
LATASIR	2,9 – 2,5	
JALAN TANAH	≤ 2,4	
JALAN KERIKIL	≤ 2,4	

Table 6 Surface Index at the End of the Design Life (SIe)

DET = Design Equivalent Traffic *)	Road Classification			
	Local	Collector	Arterial	Toll
< 10	1,0 – 1,5	1,5	1,5 – 2,0	-
10 – 100	1,5	1,5 – 2,0	2,0	-
100 – 1000	1,5 – 2,0	2,0	2,0 – 2,5	-
> 1000	-	2,0 – 2,5	2,5	2,5

12. Relative Strength Coefficients (a)

The The relative strength coefficient (a) is used to determine the strength of each pavement layer based on Marshall test results for asphalt materials, compressive strength for cement- or lime-treated materials, and CBR values for the subbase layer.

Table 7 Relative Strength Coefficients (a)

Relative Strength Coefficients			Material Strength			Material Type
a1	a2	a3	MS (kg)	Kt (kg/cm)	*CBR* (%)	
0,40	-	-	744	-	-	
0,35 0,35	- -	- -	590 454	- -	- -	Laston
0,30	-	-	340	-	-	
0,35	-	-	744	-	-	
0,31 0,28	- -	- -	590 454	- -	- -	Lasbutag
0,26	-	-	340	-	-	
0,30	-	-	340	-	-	HRA
0,26	-	-	340	-	-	Asphalt Macadam
0,25	-	-	-	-	-	Lapen (mechanically)
0,20	-	-	-	-	-	Lapen (manually)
-	0,28	-	590	-	-	
-	0,26	-	454	-	-	Upper Laston
-	0,24	-	340	-	-	
-	0,23	-	-	-	-	Lapen (mechanically)
-	0,19	-	-	-	-	Lapen (manually)
- -	0,15 0,13	- -	- -	22 18	- -	Stabilized soil with cement
- -	0,15 0,13	- -	- -	22 18	- -	Stabilized soil with lime
-	0,14	-	-	-	100	Crushed Stone (Class A)
-	0,13	-	-	-	80	Crushed Stone (Class B)
-	0,12	-	-	-	60	Crushed Stone (Class C)
-	-	0,13	-	-	70	Sirtu (Sand and Gravel (Class A)
-	-	0,12	-	-	50	Sirtu (Sand and Gravel (Class B)
-	-	0,11	-	-	30	Sirtu (Sand and Gravel (Class C)
-	-	0,10	-	-	20	Sandy/Clayey Soil

13. Pavement Thickness Index (PTI)

The Pavement Thickness Index (PTI) is intended to determine the relative strength of pavement layers used in long-term road design calculations.

The PTI is calculated using the following formula:

PTI $= a_1 D_1 + a_2 + D_2 + a_3 D_3$

Note:

a_1, a_2, a_3 = Relative strength coefficients of pavement materials

D_1, D_2, D_3 = Thickness of each pavement layer (cm)

1, 2, 3 = Represent surface layer, base course, and subbase course, respectively

14. California Bearing Ration (CBR) of Subgrade Soil

The California Bearing Ratio (CBR) is the ratio between the penetration resistance of the pavement layer and the penetration resistance of a standard material at the same depth and rate of penetration, expressed as a percentage [10].

The CBR is classified into two types:

Field CBR : Used for overlay (pavement strengthening) design.

Laboratory CBR : Used for new road design.

15. Minimum Pavement Thickness Limit

Table 8 Minimum Pavement Thickness Limit

PTI	Minimum Thickness (cm)	Material
Surface Layer		
< 3,00	5	Protective layer: Buras, Burtu or Burda
3,00 – 6,70	5	Lapen/Penetration Macadam, HRA, Lasbutag, Laston
6,71 – 7,49	7,5	Lapen/Penetration Macadam, HRA, Lasbutag, Laston
7,50 – 9,99	7,5	Lasbutag, Laston
≥ 10,00	10	Laston
Base Course		
< 3,00	15	Crushed stone, cement-stabilized soil, or lime-stabilized soil
3,00 – 7,49	10	Upper Laston
	20*)	Crushed stone, cement-stabilized soil, or lime-stabilized soil
7,50 – 9,99	15	Upper Laston
	20	Crushed stone, cement-stabilized soil, lime-stabilized soil, Macadam base
10 – 12,14	20	Crushed stone, cement-stabilized soil, lime-stabilized soil, Macadam base, Penetration Macadam (Lapen), Upper Laston
≥ 12,25	25	Crushed stone, cement-stabilized soil, lime-stabilized soil, Macadam base, Penetration Macadam (Lapen), Upper Asphalt Concrete (Laston Atas)
Subbase Course		
For any PTI value minimum 10 when a subbase layer is used		

Pavement Construction Planning

1. Design Life

The planned service life of the access road pavement construction is set for 10 years, from 2025 to 2035, in accordance with SNI 1732-1989F guidelines. Therefore, one year is allocated for the planning and construction phase (n_1), while the design service life (n_2) is established for 10 years.

2. Traffic Growth

The annual traffic growth rate is assumed to be 4.8% per year. This assumption is applied because specific traffic growth data for the study location is unavailable. Consequently, the growth factor is determined based on past traffic growth data or through through correlation with other influencing factors, as stated in the 2017 Road Pavement Design Method (MDPJ) Book, Section 4-2. In that section, it is noted that the estimated traffic growth rate for the Java region is 4.8% per year.

3. Traffic Growth

The The following are the vehicle categories considered in the access road design:

a. Light vehicles, including commando cars, utility cars, and emergency equipment kits.

b. Heavy vehicles, including ambulances and FT Type I vehicles.

Table 9 Average Daily Traffic

No	Vehicle type	Axle loads (tons)		ADT (vehicle/day)
		Front	Rear	
1	Light vehicle (3 ton)	1	2	3
2	Ambulance (6 ton)	2	4	2
3	Oshkosh, 2-axle (42 ton)	14	28	2
Total				7

The calculation of the Average Daily Traffic (ADT) in the first year of implementation is performed using Equation as follows:

$$ADT_{(beginningi\ of\ design\ life)} = \text{ADT (data) x } (1 + i)^n$$

1) Light vehicle (3 ton) $= 3 \text{ x } (1+ 0{,}048)^1$
$= 3{,}1$ vehicles/day

2) Ambulance (6 ton) $= 2 \text{ x } (1+ 0{,}048)^1$
$= 2{,}09$ vehicles/day

3) Oskosh 2-axle (42ton) $= 2 \text{ x } (1+ 0{,}048)^1$
$= 2{,}09$ vehicles/day

The calculation of the Average Daily Traffic (ADT) at the end of the design life (10th year) is carried out using the following formula:

$$ADT_{(end\ of\ design\ life)} = \text{ADT (data) x } (1 + i)^n$$

1) Light vehicle (3 ton) $= 3 \text{ x } (1+ 0{,}048)^{10}$
$= 4{,}79$ vehicles/day

2) Ambulance (6 ton) $= 2 \text{ x } (1+ 0{,}048)^{10}$
$= 3{,}19$ vehicles/day

3) Oskosh 2-axle (42 ton) $= 2 \text{ x } (1+ 0{,}048)^{10}$
$= 3{,}19$ vehicles/day

4. Determination of Vehicle Distribution Coeeficient

For the access road design at Ahmad Yani International Airport, Semarang, a single traffic lane was established based on existing conditions. Given this configuration, the vehicle distribution coefficient (C) is set to 1.0 for both light and heavy vehicles. This value is determined with reference to the number of lanes and the types of vehicles using the road.

5. Calculation of Equivalent Factor

The Equivalent Factor (E) and the axle loads of each vehicle wheel can be found in the Equivalent Factor of Vehicle Axle Load table. Based on this table, the equivalent factor is determined by referring to the magnitude of the axle loads of the operational vehicles that will use the planned access road.

a) Light vehicle (3 ton) = 0,0002 + 0,0003
= 0,0005

b) Light vehicle (3 ton) = 0,0036 + 0,005
= 0,0086

c) Oskosh 2-axle (42 ton) = 8,6647 + 1,4904
= 10,15

6. Calculation of Equivalent Factor

Below are the results of the calculations for the Initial Equivalent Traffic (LEP), Final Equivalent Traffic (LEA), Mid-period Equivalent Traffic (LET), and Average Equivalent Traffic (LER) obtained from the computations using Equations (1) through (5).

1) Initial Equivalent Traffic (IET)

IET $= ADT_{(beginningi\ of\ design\ life)}$ x C x E

a) Light Vehicle (3 ton)
IET = 3,1 x 1 x 0,0005
= 0,001

b) Ambulance (6 ton)
IET = 2,09 x 1 x 0,0086
= 0,017

c) Oskosh 2-axle (42 ton)
IET = 3,1 x 1 x 0,0005
= 0,001

The total Initial Equivalent Traffic (LEP) from all vehicle types planned is calculated as follows:

IET = 0,001 + 0,017 + 21,21
= 21,22

2) Final Equivalent Traffic (FET)

FET $= ADT_{(end\ of\ design\ life)}$ x C x E

a) Light Vehicle (3 ton)
FET = 4,79 x 1 x 0,0005
= 0,002

b) Ambulance (6 ton)
FET = 3,19 x 1 x 0,0086
= 0,02

c) Oskosh 2-axle (42 ton)
FET = 3,19 x 1 x 10,15
= 32,37

The total Initial Equivalent Traffic (LEP) from all vehicle types planned is calculated as follows:

IET = 0,002 + 0,02 + 32,37
= 32,39

3) Mid Equivalent Traffic (MET)

MET $= \frac{1}{2}$ x (IET + FET)

$= \frac{1}{2}$ x (21,22 + 32,39)

= 26,8

4) Design Equivalent Traffic (DET)

DET = MET x FP

FP $= \frac{UR}{10} = \frac{10}{10} = 1$

DET = 26,8 x 1

= 26,8

7. Determining the Pavement Thickness Index (PTI)

a) Determining the CBR Value of the Subgrade

The California Bearing Ratio (CBR) value of the subgrade is obtained based on available data from Ahmad Yani International Airport, which is 6%.

The Subgrade Bearing Capacity (SBC) is calculated using the following equation:

SBC = 4,3 Log (CBR) + 1,7

= 4,3 Log (6) + 1,7

= 5,04

Thus, the Subgrade Bearing Capacity (SBC) obtained from the correlation between the CBR value and SBC is 5.04.

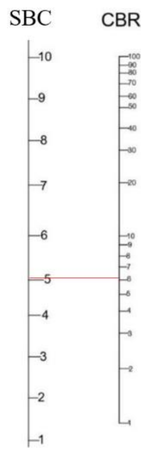

Figure 3 Correlation graph between CBR value and SBC

b) Determining of Regional Factor (RF)

The determination of the Regional Factor (RF) takes into account several parameters, including the annual rainfall data obtained from a five-year observation series recorded by the BMKG Ahmad Yani Station, the average terrain slope within the airport area, and the percentage of heavy vehicles using the planned access road. Based on the data, the average terrain slope over the past five years is 6.8%, which contributes to the overall assessment of the regional factor.

Percentage of heavy vehicles

$= \frac{Number\ of\ heavy\ vehicles}{Total\ vehicles}$ x 100%

$= \frac{8}{11}$ x 100% = 72,7%

Annual rainfall classification: climate I, < 900 mm/year.
Based on these conditions (climate class I, slope > 6%, and heavy-vehicle percentage > 30%), the Regional Factor (RF) is set to 2.0.

c) Determining Initial Surface Index (SI)

The pavement surface layer is LASBUTAG with roughness > 1000; therefore the Initial Surface Index (SI) is in the range 3.9 – 3.5

d) Determining Surface Index at the end of design life (SIe)

Given the road classification (arterial, 7 m width) and the calculated Equivalent Traffic (DET = 26.8), the SI at the end of design life (SIe) is set to 2.0.

e) Nomogram inputs (summary)

SIe	= 2.0
SI	= 3.9 – 3.5
CBR	= 6% → SBC = 5.04
RF	= 2.0
DET	= 26.8

Using the Pavement Thickness Nomogram with the above parameters yields a Pavement Thickness Index (PTI) of 6.6.

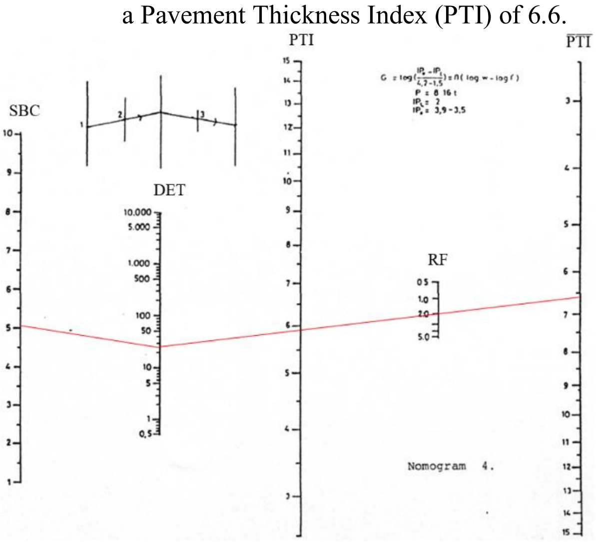

Figure 4 Nomogram of the Correlation between SBC, DET, PTI, and RF

f) Determining Surface Index at the end of design life (SIe)

The pavement layer structure of the planned access road is determined based on the minimum thickness coefficient of the surface layer, referring to the calculation results obtained previously. The pavement structure consists of the following layers:

a) Surface Course: Designed using asphalt concrete (LASBUTAG) with stability grade MS 454, having a relative strength coefficient (a_1) of 0.28.

b) Base Course: Designed using crushed stone Class A material with a CBR value of 100% and a relative strength coefficient (a_2) of 0.14.

c) Subbase Course: Designed using Class A sand and gravel (sirtu) material with a CBR value of 70% and a relative strength coefficient (a_3) of 0.13.

The next step is to determine the thickness of each pavement layer based on the minimum layer thickness criteria, resulting in the following:

Surface layer (D_1): With a PTI value of 6.6, the minimum surface thickness is 5 cm.

Base layer (D_2): With a PTI value of 3, the minimum required base thickness is 15 cm.

Subbase layer (D_3): Calculated using Equation PTI:

PTI $= a_1D_1 + a_2D_2 + a_3D_3$

Substituting the values:

PTI $= a_1D_1 + a_2D_2 + a_3D_3$

6,6 $= 0{,}28 \cdot 5 + 0{,}14 \cdot 15 + 0{,}13 \cdot D_3$

$= 1{,}4 + 2{,}1 + 0{,}13\ D_3$

$D_3 = \frac{6{,}6-3{,}5}{0{,}13}$

= 23 cm

The thickness details of each pavement layer in the access road design are presented in the following table and design summary:

Table 10 Pavement Layer Thickness

No	Pavement Layer Type	Value		Thickness (D) (cm)
1	LASBUTAG MS 454	a1	0,28	5
2	Crushed Stone Class A	a2	0,14	15
3	Sand and Gravel Class A	a3	0,13	23
	Total Pavement Thickness			43

The design of the pavement structure in this study is based on several critical parameters, including the road design life, projected traffic growth, average daily traffic, vehicle distribution coefficient, equivalent axle load factor, and Pavement Thickness Index (PTI). The reference used follows the guidelines of the Ministry of Public Works and Housing (PUPR), 1987.

The component analysis method was applied, as this approach is widely recommended for both highway and airport road construction, such as access roads [11].

Three primary data sets are crucial in this method:

1) Average daily traffic data for vehicles operating in the airside and terminal areas,
2) Subgrade CBR value of 6%, based on the Pavement Management System (PMS) document of Ahmad Yani International Airport, and
3) Rainfall data obtained from the official website of BMKG Ahmad Yani Semarang.

Is the Pavement Thickness Appropriate? (SKEP 347/XII/1999)

Based on the calculations using this method, the pavement layer thickness complies with the requirements stated in SKEP 347/XII/1999 on Standards for Airport Facility Construction and Engineering, which specify a surface course thickness of 5 cm, a base course thickness of 15 cm, and a subbase course thickness of 23 cm.

Draft Budget Cost Calculation

The Draft Budget Cost (DBC) is an essential financial tool used to estimate the costs required for each component of a construction project. This plan provides a detailed breakdown of all the expenses involved, ensuring that every aspect of the project is accounted for financially. By using the Draft Budget Cost, project managers and stakeholders can determine the total cost necessary to complete the project, enabling effective budgeting and financial management.

The preparation of the Draft Budget Cost (RAB) refers to the Standard Cost Analysis (HSPK) of Semarang City for the year 2025. These standardized unit prices provide a reliable reference to ensure that the cost estimates align with the prevailing local economic conditions. To enhance transparency and accuracy, a more detailed unit price analysis and work volume analysis are included in the appendix. This additional documentation offers a deeper breakdown of the cost components, allowing for a thorough review and ensuring that all aspects of the budget are carefully accounted for to support effective project management and implementation.

In the calculation of the Draft Budget Cost, determining the work volume is a crucial initial step. The work volume includes estimates of the quantities of materials, labor, and equipment required to execute the project. By accurately calculating the work volume, planners can determine the exact resource and cost requirements. This ensures that the prepared budget realistically reflects the project's needs and allows for effective planning and cost management during the execution phase.

The work volume calculations include:

1) Calculation of the measurement work area
2) Calculation of access road work volume
3) Calculation of the earthwork area
4) Calculation of pavement construction layer work volume

The following are the details of the Draft Budget Cost (RAB) for the access road construction project at Jenderal Ahmad Yani International Airport.

Table 11 Budget Plan

Budget Plan					
Project : Access Road Construction Province : Central Java Location : Jenderal Ahmad Yani International Airport					
No	Description of Work	Volume	Unit	Unit Price (Rp)	Total Price (Rp)
a	b	c	d	e	f = c*e
A	Preparation Work				
1	Surveying Work	2,288	Ha	2.228.744,27	5.099.366,89
2	Project Signboard	1	Package	1.382.304,10	1.382.304,10
3	Mobilization	1	ls	4.950.000,00	4.950.000,00
Total Preparation Work					11.431.670,99
B	Earthwork				
1	Clearing dan Grubbing	22.880,00	ma²	14.594,00	333.910.720,00
2	Excavation Work	1.822,80	m³	86.527,47	157.722.094,93
Total Earthwork					491.632.814,93
C	*Access Road Construction*				
1	Class A Sand-Gravel Layer	974,98495	m³	249.583,18	243.339.846,82
2	Class A Crushed Stone Base Course	635,85975	m³	1.948.037,35	1.238.678.543,79
3	Asphalt Treated Base	498,0901375	ton	1.300.691,65	647.861.680,79
Total Access Road Construction					2.129.880.071,40
Grand Total (A+B+C)					2.632.945.000,00
VAT 11%					289.623.950,00
Total Amount					2.922.568.950,00
In Words	*Two Billion Nine Hundred Twenty-Two Million Five Hundred Sixty-Eight Thousand Nine Hundred Fifty Rupiah*				

Conclusion

Based on the results of the analysis and calculations that have been thoroughly conducted in the previous chapter, several important conclusions can be drawn. These conclusions provide a comprehensive understanding of the data and insights obtained, which are crucial for making informed decisions and recommendations for the project.

1) The design of the PKP-PK access road at Jenderal Ahmad Yani International Airport, Semarang resulted in a road with a length of 400 meters, width of 7.2 meters, and a turning radius

of 25 meters. The flexible pavement structure consists of three layers with a total thickness of 40 cm—a 5 cm LASBUTAG MS454 surface course, a 15 cm Class A crushed stone base course, and a 20 cm Class A sand-gravel (sirtu) subbase course. This design is based on local CBR values and adheres to technical standards set out in the 1987 Bina Marga Component Analysis Method and SKEP/347/XII/1999 for airport facilities.

It is recommended that future research further refine the access road design by incorporating supporting infrastructure studies, including drainage systems, emergency lighting, and PKP-PK lane markings. Additionally, implementing a life cycle cost analysis (LCCA) is advised to evaluate the long-term performance, maintenance efficiency, and sustainability of the pavement design.

2) Based on calculations using the 2025 Semarang City HSPK, the total estimated construction cost for the PKP-PK access road is Rp 2,948,898,400.00 (two billion nine hundred forty-eight million eight hundred ninety-eight thousand four hundred rupiah). This budget covers all key work items, including preparation, earthwork, base and pavement layers, as well as project maintenance and supervision.

It is advised that the airport management of Jenderal Ahmad Yani International Airport, in coordination with relevant authorities, implement the construction of the PKP-PK access road in accordance with the approved design and specifications. Establishing a regular and continuous maintenance program is essential to preserve pavement quality and ensure effective emergency response operations, serving as a benchmark for other airports that have not yet developed dedicated PKP-PK access roads.

REFERENCES

[1] Muliandhi, P., Nugroho, A. K., & Aji Jr., E. B. (2023). Otomatisasi Sistem Bagasi Terminal Internasional Di Bandar Udara Jenderal Ahmad Yani Semarang. *Techné : Jurnal Ilmiah Elektroteknika*, *22*(2), 305–318. https://doi.org/10.31358/techne.v22i2.380

[2] Laksono, B. I. & Suprapti. (2024). Analisis Kesiapan Petugas Pertolongan Kecelakaan Penerbangan Dan Pemadam Kebakaran (PKP-PK) Dalam Kecelakaan Pesawat Di Bandar Udara Tunggul Wulung Cilacap. *Jurnal of Management and Social Sciences*, *2*(2), 12–26. https://doi.org/10.59031/jmsc.v2i2.379

[3] Chaerunnisa, K., Saleh, L. M., & Awaluddin, A. (2022). Identifikasi Hazard Dan Risk K3 Unit ARFF Bandara Sultan Hasanuddin Makassar. *Hasanuddin Journal of Public Health*, *3*(1), 32–46. https://doi.org/10.30597/hjph.v3i1.20217

[4] Lukiana, L. (2017). Pemeliharaan Kendaraan PKP-PK di Bandar Udara Hang Nadim-Batam. *WARTA ARDHIA*, *41*(2), 81–96. https://doi.org/10.25104/wa.v41i2.147.81-96

[5] Syafutra, E., Sukmana, I., & Murdapa, F. (2022). Perencanaan Lapis Perkerasan Lentur dengan Metode Analisa Komponen pada Jalan Provinsi Ruas Jalan Kota Gajah - Seputih Surabaya Kabupaten Lampung Tengah. Seminar Nasional Insinyur Profesional (SNIP), *2*(2). 1-9. https://doi.org/10.23960/snip.v2i2.263

[6] PUPR. (n.d.). Petunjuk Konstruksi Jalan PISEW 2023 Kementrian Pekerjaan Umum dan Perumahan Rakyat.

[7] Rahmansyah, E. A., Irfansyah, M. F., & Indratmo, D. (2015). Perencanaan Peningkatan Jalan Ruas Trenggalek Batas Pacitan STA. 4+000 - STA 7+000. Dengan Menggunakan Perkerasan Lentur, Provinsi Jawa Timur. Tugas Akhir. Institut Teknologi Sepuluh Nopember. Surabaya, Indonesia. Taken from https://repository.its.ac.id/70960/

[8] Arthono, A., & Permana, V. A. (2022). Perencanaan Perkerasan Lentur Jalan Raya Menggunakan Metode Analisa Komponen SNI 1732-1989-F Ruas Jalan Raya Mulya Sari Kecamatan Pamanukan Sampai Kecamatan Binong Kabupaten Subang Propinsi Jawa Barat. Jurnal Komposit, *6*(1), 41-51. https://doi.org/10.32832/komposit.v6i1.6740

[9] Zahra, I. A., Hasanuddin, A., Hayati, N. N., & Sulistyono, S. (2022). Perencanaan Peningkatan Akses Jalan Bandar Udara Notohadinegoro Jember. *Jurnal Rekayasa Sipil Dan Lingkungan*, *5*(1), 28-36. https://doi.org/10.19184/jrsl.v5i1.10903

[10] Umamul Husen, & Ir. Darmadi, M. (2022). Analisis Perkerasan Lentur (Flexible Pavement) Jalan Inspeksi (*Check Road*) Perimeter Selatan Di Bandara Soekarno-Hatta, Tangerang Banten. 1–21.

[11] Wicaksono, Z. A., Wasito B., & Hariyadi, S. (2021). Perencanaan Flexible Pavement Access Road Kendaraan PKP-PK di Bandar Udara Depati Parbo Kerinci. Tugas Akhir. Politeknik Penerbangan Surabaya. Surabaya, Indonesia. Taken from https://repo.poltekbangsby.ac.id/id/eprint/836/1/30718048-TA-PUB.pdf