PLANNING FOR THE EXTENSION OF RUNWAY 01 FOR A330-200 AIRCRAFT TYPE AT KALIMARAU BERAU AIRPORT

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ABSTRACT

The BLU Kalimarau Class I Airport Operator Unit is an airport located in East Kalimantan, precisely in Teluk Bayur District, Berau Regency. In the detailed plan for the development of Kalimarau Airport runway facilities, the largest types of aircraft planned for Phase II are B737-400 and B737-500 with a runway of 2,500 x 45 m. Currently the largest aircraft in operation are the B737-800 and A320. Judging from the increase in the number of passengers, supporting the development of the IKN and the plan for the Umrah embarkation, it is necessary to extend the runway in the near future. The author uses the Airbus A330-200 plan aircraft. The methods used were linear regression analysis, ARFL calculation and pavement thickness calculation and bearing capacity value using FAARFIELD and COMFAA. The results of the analysis obtained the number of passengers in the next 20 years of 2,240,292 passengers, the A330-200 aircraft can start operating at Kalimarau Airport in 2037. It takes an extension of the runway by 400 m to 2,650 x 45 m with a total thickness of 91.9 cm and a PCN value of 90 F/C/X/T.

Keywords: *Runway, Runway Extension, PCN, COMFAA, FAARFIELD*

1. INTRODUCTION

In the Detailed Technical Design of the Air Side and the master plan of Kalimarau Airport, the development of the development of the development of runway facilities in detail is presented in the type of aircraft the largest plan operated in Phase II is the B737-400 and B737-500, requiring a runway length of 2,500 m x 45 m so that an extension of the runway of 250 m is required on runway 01. Reviewing that the largest aircraft operating at Kalimarau Airport are currently the B737-800 and A320, judging from the increase in the number of passengers in the future. Supporting the IKN in the future and there will be a runway extension plan in the near future, therefore a runway extension plan is needed to support airport operations and the addition of aircraft in the future. In this study, the author uses the A330-200 plan aircraft as the most critical plan aircraft at Kalimarau Airport because the future plan is that Kalimarau Airport will serve Umrah embarkation.

In passenger forecasting analysis, a simple linear regression analysis is used. Simple linear regression analysis was performed using Microsoft Excel and SPSS software. The data from 2010-2014 was used because of the requirements to obtain a good linear regression analysis model, one of which is that the data used is normally distributed and there is a significant linear relationship between variables X and Y (Yusuf Alwy et al., 2024). From the description of the problems above, it is necessary to calculate the passenger forecast for the next 20 years, forecast when the A330-200 aircraft can start operating at Kalimarau Airport, plan for the extension of the runway that is adjusted to the specifications of the Airbus A330-200 aircraft, plan the thickness of the pavement to support the operation of the Airbus A330-200 which is based on the FAA Manual method and the FAARFIELD 2.0.18 program and determine the bearing capacity of the pavement using the COMFAA 3.0 program.

2. THEORETICAL FOUNDATION

2.1 Airport

Airports in Law Number 1 of 2009 concerning aviation have the meaning of areas on land and/or waters with certain boundaries that are used as places for aircraft to land and take off, board and disembark passengers, load and unload goods, and places for intra- and intermodal transportation transfers, which are equipped with aviation security and security facilities, as well as basic facilities and other supporting facilities.

2.2 Runway

According to the Decree of the Director General of Perhubud Number PR 21 of 2023, a runway is a rectangular area that has been determined in the land aerodrome for aircraft landing or takeoff. Runway length requirements vary depending on the type of aircraft and the local geography. Local conditions that must be considered are elevation, temperature, runway slope, humidity and runway surface characteristics.

2.3 Runway Extension

The runway length used to support the aircraft that will operate is called Aeroplane Reference Field Length or ARFL. To determine the runway length, the plan should not only use ARFL because ARFL depends on various factors such as altitude, aerodrome altitude, reference temperature and runway slope.

2.3.1 Elevation Correction Factor

The runway length requirement will increase with each elevation increase of 300 m against the basic length. The following is the formula to calculate the correction factor to the elevation.

$$Fe = 1+(0.07 \times h/300) \quad (1)$$

Where:
Fe : Elevation correction factor
h : Elevasi Aerodrome (m)

2.3.2 Temperature Correction Factor

The runway length requirement will increase by 1% for every 1 degree Celsius increase in the aerodrome reference temperature against the standard altitude temperature of the land aerodrome. For every 1000 m rise above sea level, the temperature drops by 6.5 degrees Celsius. The following is the formula to calculate the correction factor to temperature.

$$Ft = 1+0.01 (T-(15- 0.0065 \times h)) \quad (2)$$

Where:
Ft : Temperature correction factor
h : Elevasi Aerodrome (m)
T : Temperature aerodrome referensi (ºC)

2.3.3 Slope Correction Factor

For each 1% slope of runway lengthening, runway needs increase by 10%. The following is the formula to calculate the correction factor to the slope

$$Fs = 1+ (0.1 \times s) \quad (3)$$

Where:
Fs : Slope correction factor
s : runway slope (%)

2.3.4 ARFL

After the aerodrome altitude correction factors are known, the reference temperature correction and the runway slope correction are known, the ARFL can be calculated so that the planned runway needs can be known using the following formula.

$$ARFL = \frac{Lr}{Fe \times Ft \times Fs} \quad (4)$$

Where:

Fe : Elevation correction factor
Ft : Temperature correction factor
Fs : Slope correction factor
Lr : the length of the runway plan

2.4 Characteristic of the Aircraft Plan

Aircraft characteristics such as the weight or weight of the aircraft are the most influential in the design of runways, taxiways, ramps, aprons, service facilities, gate terminals and security facilities because the runway must be able to support the weight of the operating aircraft. In this study, the author uses the A330-200 plan aircraft as the most critical plan aircraft at Kalimarau Airport. The following are the specifications and detailed drawings of the dimensions of the A330-200 aircraft.

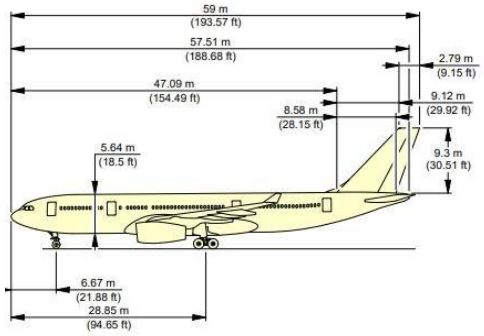

Figure 2. 1 Airbus A330-200 Side View
(Source : Airbus, 2023)

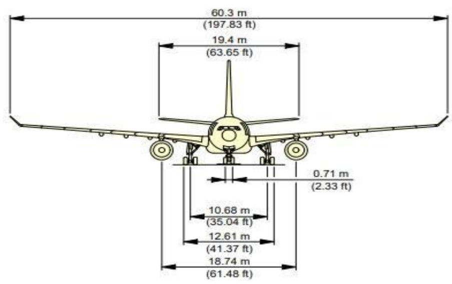

Figure 2. 2 Airbus A330-200 Front View
(Source : Airbus, 2023)

2.5 Forecastiong

Forecasting or forecasting is estimating the amount or amount of something in the future using data that already existed in the past and then analyzed in a natural way and in a special way using statistical methods. In this study, a simple manual linear regression analysis with Microsoft Excel and a linear regression analysis using

SPSS software were used in calculating the forecast of the number of passengers at Kalimarau Airport in 2024-2044 so that equivalent annual departure can be calculated.

According to Hintarsyah et al. (2018), simple linear regression analysis is one of the regression methods used as a statistical intervention tool to determine the influence of an independent variable on the dependent variable. Simple linear regression or called simple linear regression is a statistical method that is most often used in planning to determine the capacity and efficiency of a plan. Here's a simple linear regression equation:

$$Y' = a + bX \qquad (5)$$

Where:
Y': response or consequence variable (dependent)
X : causal variable or predictor (independent)
A: constant
b : regression coefficient/response magnitude generated by the predictor

2.6 Flexible Pavement

The definition of pavement in KP 94 of 2015, pavement is an infrastructure consisting of several layers with different strengths and supporting capabilities. Flexible pavement is a pavement that has elastic properties so that it will sag when loaded. Flexible pavement is a pavement made from a mixture of asphalt and aggregate spread on a surface of high-quality granular material. The construction of flexural pavement supports loads based on load limitations, not based on bending stress. On the bending pavement, the load is distributed to each layer below it does not exceed the capacity/carrying capacity of the layer.

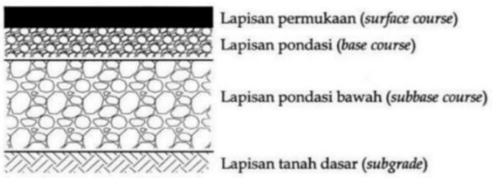

Figure 2. 3 Flexible Pavement Structure
(Source : SKEP 003/I/2005)

2.6.1 Flexible Pavement Structure

The following is the structure of the flexible pavement layer in KP 94 of 2015.

1. Surface Layer (Surface Course)

This surface layer consists of a mixture of selected aggregates bound by asphalt. The function of this surface layer is to withstand the influence of the applied load and distribute the load to the layer below, support the shear force caused by the aircraft wheels, provide a smooth surface, retain water during rain so that it does not seep into the lower layer and can increase the carrying capacity of the layer against the load of the traffic wheel

2. Top Foundation Layer (Base Course)

The upper foundation layer consists of granular material that is processed or unprocessed. Just like the surface layer, the upper foundation layer must be able to withstand the influence of loads and environmental influences and distribute the load to the layers below. The upper foundation layer must be of sufficient quality and thickness to prevent failure or damage to the lower foundation layer and/or the subsoil, withstand the stress generated by the foundation layer itself, withstand vertical pressure and prevent volume changes caused by fluctuations in moisture content.

3. Bottom Foundation Layer (Subbase Course)

The bottom layer of foundation is used in areas where the subsoil layer is very weak. The bottom foundation layer has the same function as the top foundation layer. Whether or not the bottom foundation layer is necessary or not is seen from the type of pavement load, as well as the type of soil and the strength of the base soil.

4. Subsoil Layer (Subgrade)

The subsoil layer is a compacted layer of soil that forms the foundation of a structural system. The ground soil is one of the main factors that affect the design of airport pavement planning. The subsoil is made to withstand a smaller stress than the stress borne by the surface layer and foundation layer.

2.6.2 Pavement Materials

The following is the flexible pavement material described in SKEP 003/I of 2005.

1. Surface Layer (*Surface Course*)

The surface layer is a concrete asphalt formed from finely graded aggregate and bitumen mixed in a *hot hotmix* and compacted in the field to provide a flat surface. For the surface coating, P-401 HMA *Hot Mix Ashpalt* material is used which is a mixture of mineral aggregate and asphalt material in *the central mixing plant*.

2. Top Foundation Layer (*Base Course*)

Materials that can be used for the *foundation layer of the base course* for the granular base are as follows:

a. P-208 *Aggregate base course*
b. P-209 *Crushed aggregate base course (standart)*
c. P-211 *Lime rock base course*

3. Bottom Foundation Layer (*Subbase Course*)

On the bottom layer of the foundation, the materials that can be used are as follows:

a. P-154 *Subbase course*
b. P-210 *Caliche base course*
c. P-212 *Shell base course*

d. P-213 *Sand clay base coure*

e. P-301 *Soil cement base course*

4. Subsoil Layer (*Subgrade*)

Laboratory CBR tests based on ASTM D-1883 and field CBR tests should still be carried out to determine the CBR value of the subsoil to be used in the design of flexural pavements. The CBR value used for planning purposes should not be taken greater than 85% of the laboratory's CBR value. In the design of flexible pavement, the CBR value of the subsoil should not be less than 3%. If this happens, it is necessary to improve the bottom soil. Improvement of subsoil can use stabilization methods, pile pile methods, good soil displacement methods, loading methods, vertical drainage methods and surface soil improvement.

2.7 PCN

In PR 21 of 2023, PCN or *Pavement Classification Number* is a number that states that the strength of the pavement surface for operations is unlimited. The reported PCN must show that an aircraft with an *Aircraft Classification Number* (ACN) equal to or less than the reported PCN can operate on this pavement with restrictions on wheel pressure, or *aircraft all-up mass* for the specified aircraft types.

2.8 ACN

In PR 21 of 2023, ACN or Aircraft Classification Number is a value that states the relative impact of an aircraft on pavement for a certain subgrade standard category. For flex pavement, occasional movement of an aircraft with an ACN that does not exceed 10 percent of the reported PCN will not have an unintended impact on the pavement. The following are the regulations on the value of PCN and ACN in SKEP 77 of 2005.

a. PCN > ACN ⩽ 1,1 PCN (for flexible pavement)

b. PCN > ACN ⩽ 1,05 PCN (for rigid pavement)

3. RESEARCH METHOD

In the preparation of this final project, the author uses a descriptive method of analysis. The descriptive method of analysis is a method that aims to provide an overview of the research subject based on variable data obtained from certain subject groups. The descriptive method of analysis, in addition to describing events, symptoms and events in the field, also includes asking questions, collecting data, analyzing data to answer questions, formulating and writing research reports. In planning the extension of the runway, it is carried out according to the flow chart from the start to the end or the final results of the research are known as follows (Figure 3.1).

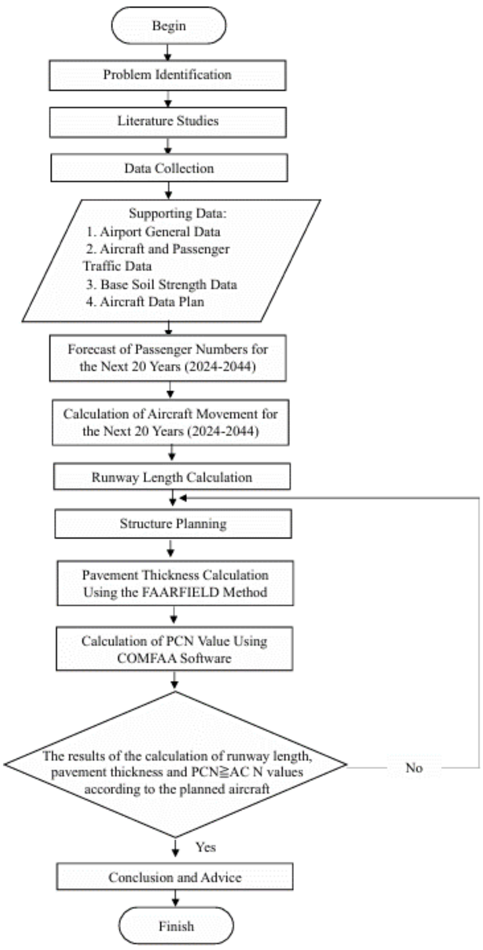

Figure 3. 1 Flowchart
(Source : Author's Report, 2024)

4. RESULT AND DISCUSSION

4.1 Data Analysis

4.1.1 Passenger Data

In the 2010-2014 passenger data for departing and arriving passengers, the Kalimarau Airport terminal has successively increased. Passenger movement data, both departing and arriving passengers, will later be used in forecasting the projection of departing and arriving passengers for the next 20 years. The increase in the number of passengers can be seen in table 4.1 below

Table 4. 1 Passenger Growth Data

	Year	Domestic Passenger (persons)		Total	Growth (%)
		Arrive	Departure		
1	2010	90.371	103.799	194.170	
2	2011	144.370	153.447	297.817	53%
3	2012	174.942	181.021	355.963	20%
4	2013	195.960	198.644	394.604	11%
5	2014	217.738	225.406	443.144	12%
Average Growth					24%

Source : Kalimarau Airport, 2024

4.1.2 Aircraft Movement Data

Aircraft movement data, both incoming and departing aircraft at Kalimarau Airport, will later be used as a reference in forecasting aircraft movements operating for the next 20 years as well as forecasting daily aircraft movements and aircraft movements during peak hours. The following is data on the movement of aircraft arriving and departing from Kalimarau Airport in 2010-2014.

Table 4. 2 Aircraft Movement Data

	Year	Aircraft Movement		Total
		Arrive	Departure	
1	2010	2.441	2.392	4.833
2	2011	2.388	2.378	4.766
3	2012	2.570	2.606	5.176
4	2013	3.060	3.054	6.144
5	2014	3.611	3.607	7.218
Total				28.107

Source : Kalimarau Airport, 2024

4.2 Passenger Forecast Calculation

4.2.1 Analysis Using SPSS

Simple linear regression analysis using SPSS software has the goal of calculating the mean estimated value and the value of the bound variable based on the value of the free variable, as well as forecasting the average value of the independent variable based on the value of the free variable outside the sample range. The following are the steps to input data in SPSS software:

1. Open SPSS Software

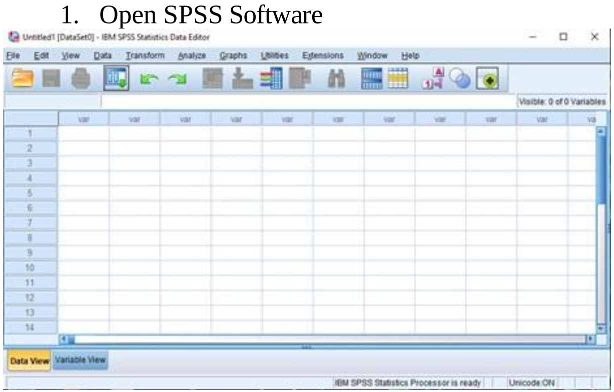

Figure 4. 1 Initial View SPSS Program
(Source : Author's Report, 2024)

2. In the variable view sheet, label X on the year data and label Y as the number of passengers as shown in the following image

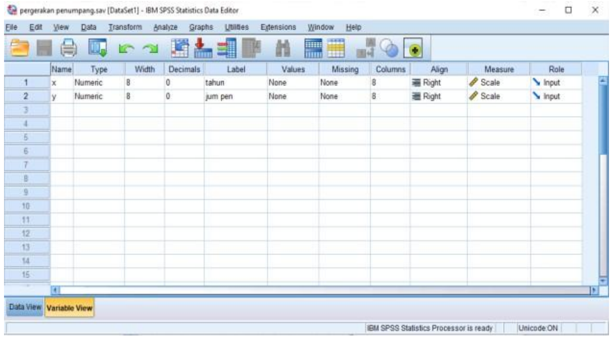

Figure 4. 2 Data Input of Variabel X and Y on the Variable View Sheet
(Source : Author's Report, 2024)

3. In the data view sheet, enter the data on the number of passengers that will be used for forecasting along with the year as shown in the following image.

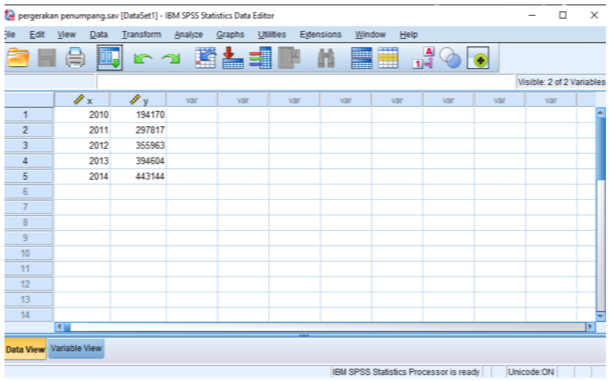

Figure 4. 3 Data Input of Number of Passengers and Year on the Data View Sheet
(Source : Author's Report, 2024)

4. After all the data is entered into the SPSS, then the passenger data is analyzed by selecting the analyze – regression – linear menu as shown in the following image

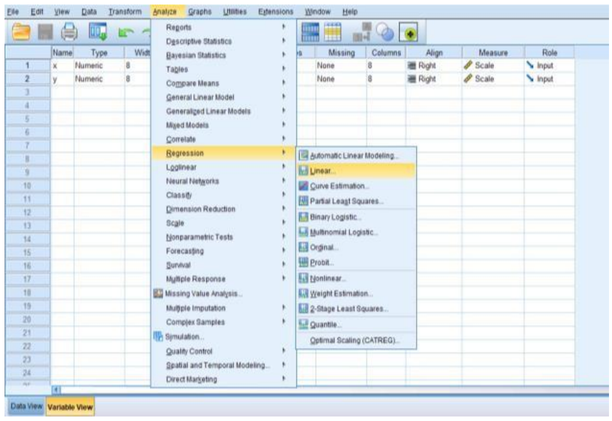

Figure 4. 4 Select the Linear Regression Analysis Menu
(Source : Author's Report, 2024)

5. Next, the following display will appear. Enter the number of passengers or variable Y as the dependent variable and the year data or variable X as the independent variable. Then click OK.

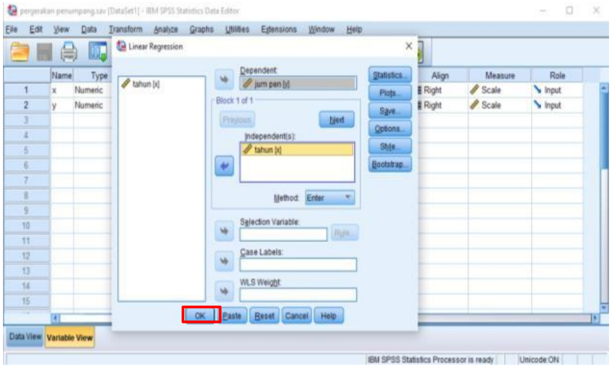

Figure 4. 5 Dependent and Independent Variable Inputs
Source : Author's Report, 2024

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	-119323542	14269665.11		-8.362	.004
	tahun	59473.500	7092.277	.979	8.386	.004

a. Dependent Variable: jum pen

Figure 4. 6 Coefficient Output
Source : Author's Report, 2024

The output of *the coefficient* results shows an overview of the regression equation sought, the value a is shown in column B *constant*, which is -119323542 and the value b is shown in column B of the year, which is 54973.5 with a significant probability of 0.004 < 0.05, so that the regression model can be used to predict the variable number of passengers. So that a linear regression equation using spss is obtained, namely:

Y'= -119323542 + 54973,5X

From the calculation using the linear regression equation for passenger forecasting from 2015-2044 using SPSS software, it can be seen from the following table

Table 4. 3 Results of Forecasting the Number of Passengers Using SPSS Software

Year	Number of Passengers
2024	1.050.822
2025	1.110.296
2026	1.169.769
2027	1.229.243
2028	1.288.716
2029	1.348.190
2030	1.407.663
2031	1.467.137
2032	1.526.610
2033	1.586.084
2034	1.645.557
2035	1.705.031
2036	1.764.504
2037	1.823.978
2038	1.883.451
2039	1.942.925
2040	2.002.398
2041	2.061.872
2042	2.121.345
2043	2.180.819
2044	2.240.292

Source : Author's Report, 2024

4.2.2 Analysis Using Microsoft Excel

Linear regression analysis using Microsoft Excel is carried out by calculating X and Y where the year data as X and the number of passengers as Y are then calculated according to the following table.

Table 4. 4 Forecasting the Number of Passengers Using Microsoft Excel

Year	X	X^2	Y	XY	Y^2
2010	1	1	194170	194170	37701988900
2011	2	4	297817	595634	88694965489
2012	3	9	355963	1067889	126709657369
2013	4	16	394604	1578416	155712316816
2014	5	25	443144	2215720	196376604736
Sum	15	55	1685698	5651829	605195533310

Source : Author's Report, 2024

Then determine the values a and b to be able to analyze the number of passengers in the future using the linear regression equation as follows.

$$a = \frac{(\Sigma y)(\Sigma x^2) - (\Sigma x)(\Sigma xy)}{n(\Sigma x^2) - (\Sigma x)^2}$$

$$b = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{n(\Sigma x^2) - (\Sigma x)^2}$$

$$a = \frac{(1685698)(55) - (15)(5651829)}{5(55) - (15)^2} = 158719$$

$$b = \frac{5(5651829) - (15)(1685698)}{5(55) - (15)^2} = 59473{,}5$$

A linear regression equation using *Microsoft Excel* is obtained, namely :

Y'= 158719 +59473,5X

From the calculation using the linear regression equation for passenger forecasting from 2015-2044 using Microsoft Excel, it can be seen from the following table.

Table 4. 5 Passenger Forecast Results using Microsoft Excel

Year	Number of Passengers
2024	1.050.822
2025	1.110.295

Year	Number of Passengers
2026	1.169.769
2027	1.229.242
2028	1.288.716
2029	1.348.189
2030	1.407.663
2031	1.467.136
2032	1.526.610
2033	1.586.083
2034	1.645.557
2035	1.705.030
2036	1.764.504
2037	1.823.977
2038	1.883.451
2039	1.942.924
2040	2.002.398
2041	2.061.871
2042	2.121.345
2043	2.180.818
2044	2.240.292

Source : Author's Report, 2024

4.3 Calculation of Peak Hours Passengers

The following are the results of the calculation of passengers during peak hours with data from the analysis of passenger calculations using data from forecasting results using SPSS software along with the number of daily passengers referring to the Regulation of the Minister of Transportation of the Republic of Indonesia Number PM 41 of 2023 concerning Airport Services at the Airport

Table 4. 6 Peak Hours Passenger Forecast

Year	Daily	Peak Hours
2024	2879	841
2025	3042	888
2026	3205	936
2027	3368	983
2028	3531	1031
2029	3694	1079
2030	3857	1126
2031	4020	1174
2032	4182	1221
2033	4345	1269
2034	4508	1316
2035	4671	1364
2036	4834	1412
2037	4997	1459
2038	5160	1507
2039	5323	1554
2040	5486	1602
2041	5649	1649
2042	5812	1697
2043	5975	1745
2044	6138	1792

Source : Author's Report, 2024

4.4 Aircraft Movement Calculation

After knowing the number of daily passengers and peak hours, then a forecast is carried out for the calculation of aircraft movements for the next 20 years based on aircraft movement data in 2010-2014 as follows.

Table 4. 7 Forecast of Passenger Movement and Fleet Needs 2024-2044

Year	Fleet Needs				Movement			
	Frequency (LF = 70%)				Aircraft	Passenger		
	CESNA 208 (12 SEAT)	ATR72-600 (72 SEAT)	BOEING 737-800 (162 SEAT)	AIRBUS A330-200 (260	Peak Hours	Daily	Peak Hours	arrive/departure
		70% = 50	70% = 113	70% = 182	(aircraft/peak hours)	(pax/day)	(pax/day)	
	1x in a day	1x in a day	1x in a day	1x in a day				
2023	1	2	3		12	2716	650	1358
2024	1	2	3		12	2879	698	1439
2025	2	2	3		14	3042	746	1521
2026	2	3	3		16	3205	793	1602
2027	2	3	3		16	3368	841	1684
2028	2	4	3		18	3531	888	1765
2029	2	4	3		18	3694	936	1847
2030	2	5	3		20	3857	983	1928
2031	2	5	3		20	4020	1031	2010
2032	2	5	4		22	4182	1079	2091
2033	2	5	4		22	4345	1126	2173
2034	2	5	4		22	4508	1174	2254
2035	2	5	4		22	4671	1221	2336
2036	2	5	4		22	4834	1269	2417
2037	2	5	3	1	22	4997	1316	2499
2038	2	5	3	1	22	5160	1364	2580
2039	2	5	3	1	22	5323	1412	2662
2040	2	5	4	1	24	5486	1459	2743
2041	2	5	4	1	24	5649	1507	2824
2042	2	5	4	1	24	5812	1554	2906
2043	2	5	4	1	24	5975	1602	2987
2044	3	5	4	1	26	6138	1792	3069

Source : Author's Report, 2024

4.5 Runway Extension Calculation

The following are the data needed in the calculation of ARFL in the Kalimarau Airport Aerodrome Manual.

1. ARFL aircraft plan : 2,250 m
2. Reference Elevation : 33 feet/10.0584 m
3. Reference Temperature : 32ºC
4. Reference Slope : 1.19%

The following is a calculation of the correction factor to get the required runway length needed.

4.5.1 Elevation Correction Factor Calculation

The following is the calculation of the elevation factor correction using the elevation factor calculation formula.

$$Fe = 1 + (0.07 \times \frac{h}{300})$$

$$Fe = 1 + (0.07 \times \frac{10,0584}{300})$$

$$Fe = 1 + 0{,}00234696$$

$$Fe = 1{,}00234696$$

4.5.2 Temperature Correction Factor Calculation

The following is the calculation of the temperature factor correction using the temperature factor calculation formula.

$$Ft = 1 + 0.01\ (T - (15 - \ 0{,}0065\ \times\ h))$$

$$Ft = 1 + 0.01\ (32 - (15 - \ 0{,}0065\ \times\ 10{,}0584))$$

$$Ft = 1 + 0.01\ (32 - (15 - \ 0{,}0065\ \times\ 10{,}0584))$$

$$Ft = 1 + 0.01\ (32 - 14{,}9346204)$$

$$Ft = 1 + 0.01\ (17{,}0653796)$$

$$Ft = 1 + 0{,}170653796$$

$$Ft = 1{,}170653796$$

4.5.3 Slope Correction Factor Calculation

The following is the calculation of the slope factor correction using the slope factor calculation formula.

$$Fs = 1 + \ (0.1\ \times\ s)$$

$$Fs = 1 + \ (0.1\ \times\ 0{,}0119)$$

$$Fs = 1 + \ 0{,}00119$$

$$Fs = 1{,}00119$$

4.5.4 Runway Length Calcuation

After the aerodrome altitude correction factors are known, the reference temperature correction and the runway slope correction are known, the ARFL can be calculated so that the actual runway length requirement can be known using the formula and calculation for the A330-200 plan aircraft as follows.

$$ARFL = \frac{Lr}{Fe\ \times\ Ft\ \times\ Fs}$$

$$2.250 = \frac{Lr}{1{,}00234696\ \times\ 1{,}170653796\ \times\ 1{,}00119}$$

$$Lr = \ 2.250\ \times\ 1{,}00234696\ \times\ 1{,}170653796\ \times\ 1{,}00119$$

$$Lr = \ 2.643{,}294634 \approx 2.650\ m$$

Based on the calculation of the ARFL of the planned aircraft, the actual runway length needed for the A330-200 aircraft to land at Kalimarau Airport was 2,650 m. The current runway length of Kalimarau Airport is 2,250 m, so it requires an extension of 400 m to support the optimal operation of the A330-200 aircraft.

4.6 Pavement Thickness Planning Using FAARFIELD

The following data is needed in calculating the thickness of the pavement for the extension of the runway at Kalimarau Airport using the FAARFIELD program.

Table 4. 8 Pavement Thickness Design Planning Data

Aircraft Type	Annual departure	MTOW (kg)	CBR Subgrade (%)
A330-200	1.460	230.900	6%
B737-800	5.110	79.242	
ATR72-600	5.470	22.680	
C280	2.555	3.969	

Source : Author's Report, 2024

Here are the steps to calculate pavement thickness using the FAARFIELD 2.0.18 program.

1. Opening the FAARFIELD Program and Determining the Type of Pavement

The first stage is to select the new job menu then select the new flexible pavement type because this planning makes a new flexible pavement as shown in the following image.

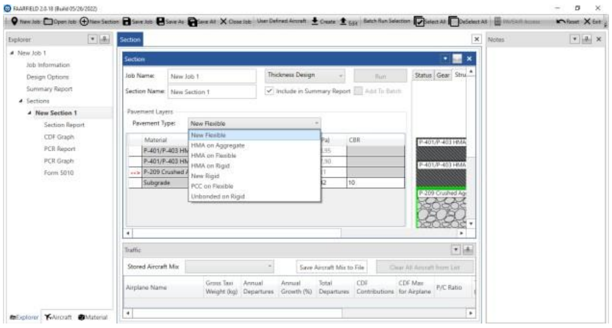

Figure 4. 7 Select Pavement Type
(Source : Author's Report, 2024)

2. Changing the Composition of the Pavement

Because the default pavement structure of FAARFIELD for the new flexible does not have an uncrushed aggregate or subbase structure (P-154 Uncrushed) and a stabilized base (ATB) because the aircraft is planned to weigh more than 100,000 lbs in accordance with KP 14 of 2021 and FAA AC-150/5320-6G in the table below, the pavement must be modified. Double-click on the P-209 crushed agregate pavement structure then select the P-154 uncrushed agregate material then click add layer below so that the P-154 material is located under the P-209 structure as shown in the following image.

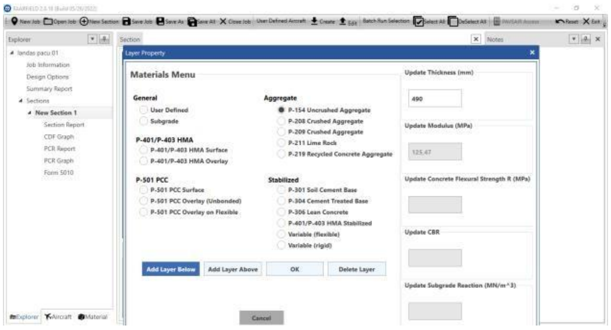

Figure 4. 8 Changing the Composition of the Pavement (Source : Author's Report, 2024)

3. Changing the CBR Subgrade Value

It is known from the pavement management system data of Kalimarau Airport that the CBR subgrade value in the runway area is 6%. Therefore the default CBR data of the FAARFIELD program should be changed to 6 as shown in the following figure.

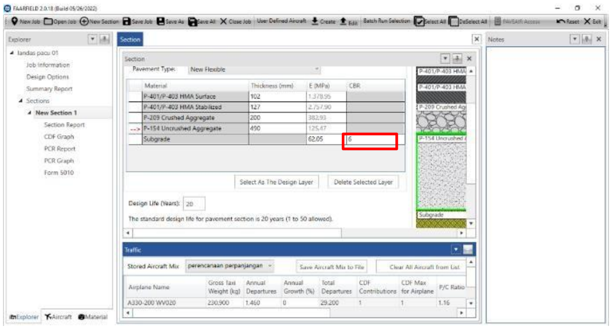

Figure 4. 9 Changing the CBR Subgrade Value (Source : Author's Report, 2024)

4. Changing Aircraft Data

After changing the CBR subgrade value, then change the aircraft data by selecting the aircraft menu, then selecting the planned aircraft that will operate and the existing aircraft. Then enter the annual departure figure according to the previous forecasting results. However, in the FAARFIELD 2.0.18 program, there is no ATR 72-600 aircraft, therefore it is replaced with a D-50 aircraft in the generic aircraft group because the D-50 aircraft is a dual wheel aircraft with a load close to the ATR 72-600 aircraft as shown in the following image.

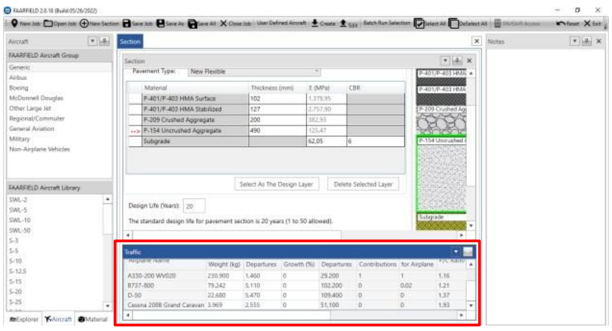

Figure 4. 10 Aircraft Data Input (Source : Author's Report, 2024)

5. Analyzing the Results of Structural Design

The design of the pavement structure that has been adjusted the pavement layer, aircraft data and subgrade CBR values are then analyzed by selecting the run option on the FAARFIELD program as shown in the following figure.

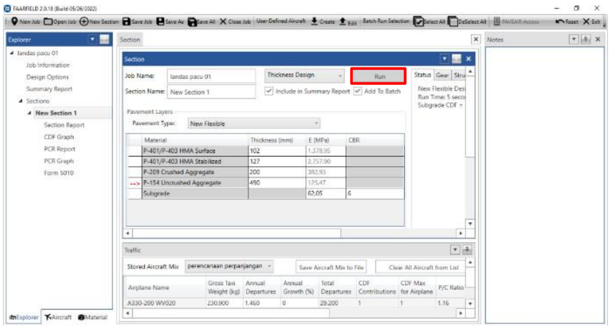

Figure 4. 11 FAARFIELD Analysis Menu (Source : Author's Report, 2024)

6. Results of Structural Design

Based on the final results of the analysis of the pavement structure by the FAARFIELD 2.0.18 program, the thickness of the subbase layer is 49 cm, the base course layer is 20 cm, the stabilized base is 12.7 cm, and the surface is 10.2 cm as follows.

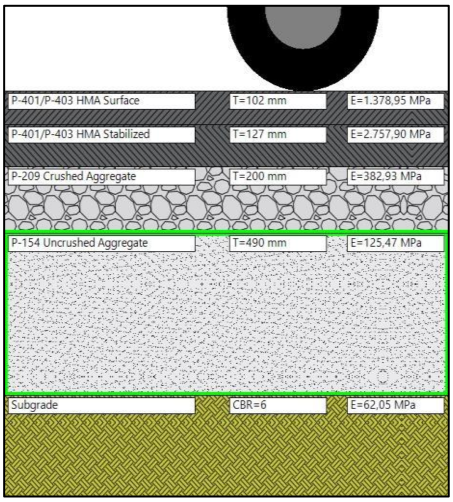

Figure 4. 12 FAARFIELD Pavement Structure Design Results

(Source : Author's Report, 2024)

4.7 Calculation of PCN Values Using COMFAA

The following are the steps to calculate the PCN value using the COMFAA program.

1. Opening the COMFAA Program and Adding Aircraft

The first step taken to calculate the PCN value using the COMFAA program is to open the COMFAA program and then add existing aircraft and planned aircraft to the aircraft group column. As in the FAARFIELD program, in the COMFAA program there is no ATR 72-600 aircraft therefore it is replaced with a D-50 type aircraft in the generic aircraft group because the D-50 type aircraft is a dual wheel aircraft with a load close to the ATR 72-600 aircraft.

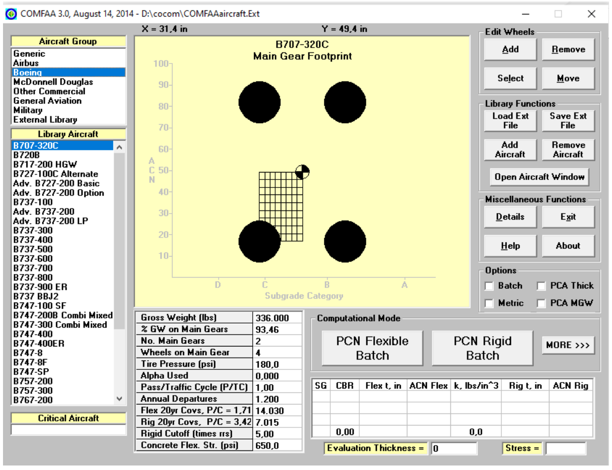

Figure 4. 13 Aircraft Group Menu Display
(Source : Author's Report, 2024)

2. Adding Annual Departures for Each Aircraft

After adding aircraft, then fill in the annual departure of each aircraft according to the previous forecasting results as follows.

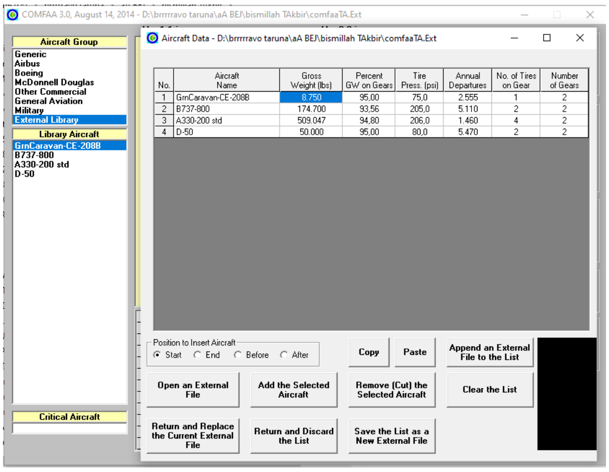

Figure 4. 14 Data Aircraft Annual Departure Data Input
(Source : Author's Report, 2024)

3. Calculating Pavement Thickness Evaluation Using Excel COMFAA Spreadsheet

Enter the thickness of the pavement structure resulting from the FAARFIELD structure design on the flexPCN sheet, change the unit into a metric and then fill in the thickness of the pavement of each layer according to the results of the analysis of the FAARFIELD program. In the P-401/P-403 material, the thickness of the pavement layer is obtained by adding a layer of HMA Surface and HMA stabilized as a result of FAARFIELD's design. Then click check the Use FAA Std Factores column and fill in the CBR subgrade value. The results of the evaluation of the pavement thickness of 1,128 mm were obtained.

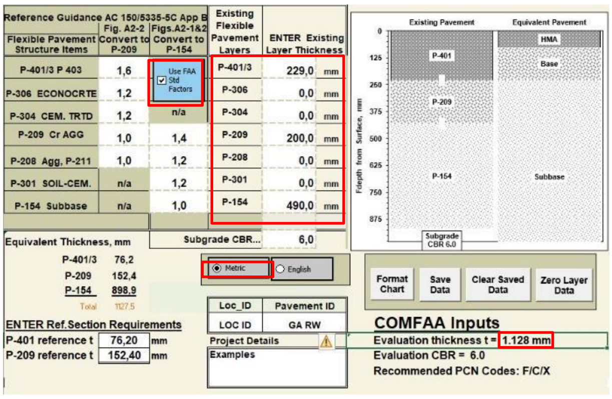

Figure 4. 15 Evaluation of FAARFIELD Pavement Structure Design Results Input
(Source : Author's Report, 2024)

4. Enter the thickness evaluation value from the Excel spreadsheet as well as the CBR value

After obtaining the thickness evaluation value from the COMFAA spreadsheet excel, then the value is entered into the COMFAA program and fills in the CBR value.

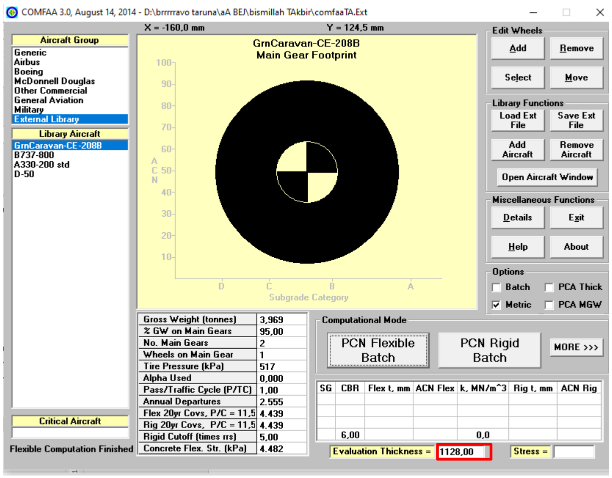

Figure 4. 16 Input of FAARFIELD Design Results Evaluation Values into COMFAA
(Source : Author's Report, 2024)

5. Select the PCN Flexible Batch option to start the PCN value analysis

The next stage is to select the PCN Flexible Batch option to start analyzing the PCN value of the pavement structure design.

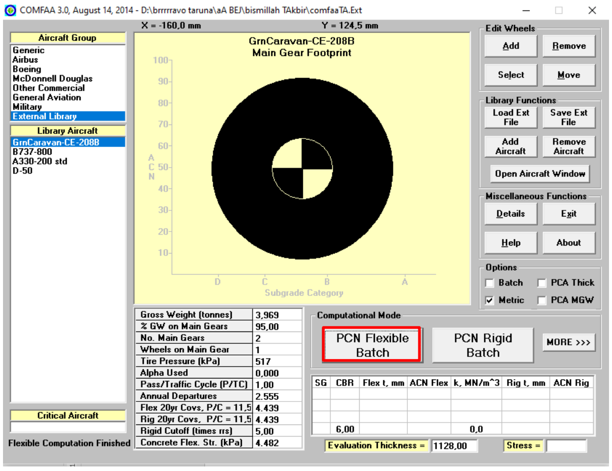

Figure 4. 17 COMFAA Program Analysis Menu
(Sourcce : Author's Report, 2024)

6. Select the detail option to view the results of the COMFAA program analysis

After the COMFAA program has finished analyzing, select the details option to display the detailed results of the aircraft's PCN and ACN values.

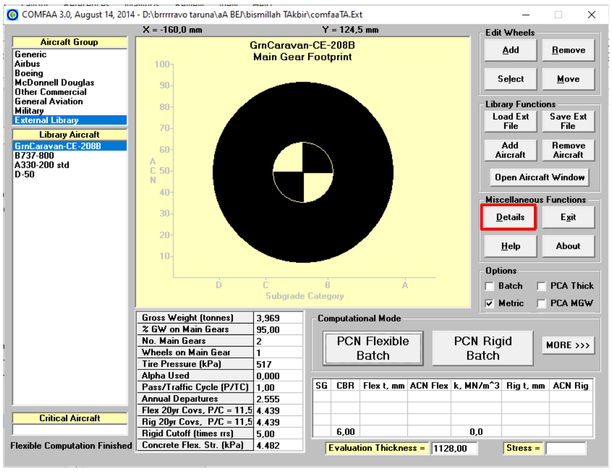

Figure 4. 18 COMFAA Program Details Options
(Source : Author's Report, 2024)

7. Results of PCN Value Analysis Using the COMFAA Program

The following are the results of the analysis of PCN and ACN values using the COMFAA program. From the output of COMFAA, the design of the pavement structure has met the requirements, namely ACN < PCN, which means that the thickness of the pavement is feasible and able to support the weight of the aircraft that will operate. Then regarding the results of the Thickness for Total Equivalent Coverage is smaller than the evaluation thickness, so it can be concluded that the thickness of the pavement structure is able to withstand the load of aircraft traffic with a PCN value of 90 F/C/X/T.

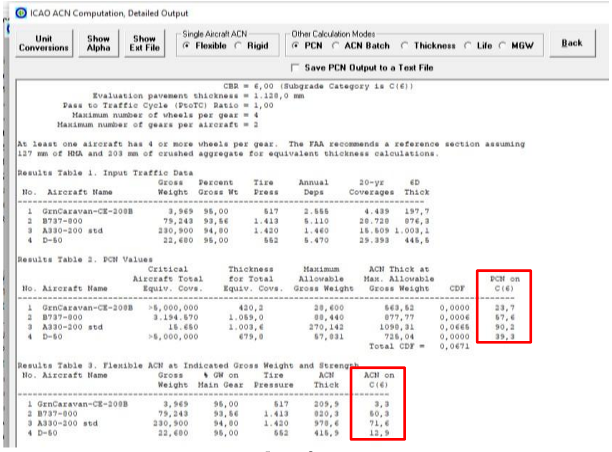

Figure 4. 19 PCN Value from COMFAA Program Analysis
(Source : Author's Report, 2024)

4.8 Final Results of Runway Structure Planning

From various analyses that have been carried out in the calculation of pavement thickness, the final results are obtained by the FAARFIELD 2.0.18 and COMFAA 3.0 correction methods, namely the PCN value of 90 F/C/X/T. The following is a recapitulation of the final results of pavement thickness planning.

Table 4. 9 Final Results of Runway Structure Planning

No	Method	Thickness	PCN (Pavement)	ACN (A330)	Note
1.	Surface (P-401/P-403)	10,2 cm	90 F/C/X/T	71,6	PCN>ACN (OKE)
2.	Stabilized Base (P-401/P-403)	12,7 cm			
3.	Base Course (P-209)	20 cm			
4.	Subbase (P-154)	49 cm			
5.	CBR Subgrade	6%			
Total Thickness		91,9 cm			

Source : Author's Report, 2024

5. CONCLUSION AND ADVICE

The number of passengers in the next 20 years, precisely in 2044, will be obtained at 2,240,292 passengers per year using the SPSS and Microsoft Excel (manual) methods. The results of forecasting passenger and aircraft movements obtained that the Airbus A330-200 aircraft can start operating at Kalimarau Airport in 2037 with a number of passengers of 1,823,978 passengers per year with the required runway length of 2,650 m x 45 m so that an extension of 400 m is needed from the existing runway length. The total thickness of the pavement was obtained of 91.9 cm, namely the P-154 UnCr Ag Subbase layer with a thickness of 49 cm, the base course P-209 Cr Ag with a thickness of 20 cm, the Stabilized base P-401/P-403 St(flex) with a thickness of 12.7 cm and the surface P-401/P-403 HMA Surface with a thickness of 10.2 cm with a PCN value of 90 F/C/X/T so that the Airbus A330-200 planned aircraft with an ACN value of 72 can operate optimally on the pavement. So it can be concluded that the planned PCN value has exceeded the ACN value of the aircraft.

Further research can be added to the calculation of the connection between the old and new pavement as well as the budget plan for the cost of extending the runway. In passenger forecasting analysis, it is better to take into account other variables that may have an effect such as economic growth, the size of the population, or special months or days

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