PLANNING OF RIGID PAVEMENT ON SURFACE LEVEL HELIPORT AT KALIMARAU AIRPORT, BERAU – EAST KALIMANTAN

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ABSTRACT

Kalimarau Airport currently does not have Surface Level Heliport facilities. Kalimarau Airport is a Home Base for helicopters to take miners and helicopter activities belonging to the TNI squadron. A Surface Level Heliport with rigid pavement is planned not only for the apron is not damaged and can be used optimally by aircraft but also for flight safety as stated in PM Perhubungan No. 35 of 2021. The planning of Surface Level Heliport uses rigid pavement because maintenance costs are cheap and the loading is evenly distributed throughout the structure. The data to compile this final project are annual departure data, soil CBR data, and determination of the existing dimension plan helicopter, from these data calculations are carried out using the FAA Manual and FAARFIELD methods. Furthermore, the results of the calculation are continued to calculate the PCN value using COMFAA Software. The results of the pavement thickness calculation 12.5 cm for the Surface layer and 10.2 cm for the Subbase layer. With a 9.3 for PCN value and 7.4 for ACN value. The maximum weight is 12,616 matrix tons and a Surface Level Heliport volume is 37 m x 37 m x 0.227 m. Marking width is 22 m x 22 m. The cost of planning based on job descriptions and PERGUB Kalimantan Timur No. 24 of 2024 is Rp. 1,591,888,000 (fairly one billion five hundred ninety-one million eight hundred eighty-eight thousand rupiah).

Keywords: *Surface Level Heliport, FAA, FAARFIELD, COMFAA, Heliport Marking, Budget Estimate Plan, Kalimarau Airport Berau – East Kalimantan.*

1. INTRODUCTION

Kalimarau Airport at Berau, West Kalimantan is one of 1st class Airport operated by The Directorate General of Civil Aviation under UPBU. It is located in Teluk Bayur District, Berau Regency, West Kalimantan.metres

The Kalimarau Airport have many airside facilities. A runway with a 45 metres width and 2250 metres length, the runway surface uses flexible pavement worth PCN 52 F / C / Y / T. Kalimarau Airport also has 3 Taxiways, Taxiway A has a 179 metres length, Taxiway B has a 167 metres length, and Taxiway C has a 187 metres length, all of the taxiways have a width of 23 metres. The Kalimarau Airport Apron has dimensions of 224 metres long and 51 metres wide and an asphalt surface with a PCN value of 21 F/C/Y/T. The airlines at the Kalimarau Airport are Wings Air, Batik Air, Citilink and Susi Air. The airport serves flight routes from Berau to Surabaya, Jakarta, Maratua, Balikpapan.

Kalimarau Berau Airport has been operating for a long time and don’t have helipad facility. Based on helicopter flight traffic data for the last 1 year, The AW169 helicopter is the most critical helicopter that has landed at Kalimarau Berau airport. The plan for making the Surface Level Heliport uses the AW169 helicopter as a critical helicopter.

Kalimarau Airport is the home base for helicopter aircraft operation to deliver miners in Berau Regency. In addition, other operational activities result in helicopter aircraft often taking off and landing in the apron area, including squadron helicopters.

Table 1. *Annual Departure*

NO	AIRLINES	A/C TYPE	PS
28-Jan-23	PEGASUS AIR SERVICES	BELL429	2
28-Feb-23	PT.NUH	EC130B4	2
28-Feb-23	PT.NUH	EC130B4	2
01-Mar-23	PT.NUH	EC130B4	2
01-Mar-23	PT. NUH	AW 169	2
01-Jun-23	MATTHEW AIR NUSANTARA	BELL 429	2
09-Jun-23	MATTHEW AIR NUSANTARA	BELL429	2
23-Jun-23	MATTHEW AIR NUSANTARA	BELL 429	2
17-Jul-23	MATHEW AIR NUSANTARA	BELL 429	2
22-Aug-23	MATHEW AIR	BELL 429	2
22-Aug-23	POLISI	AW169	8
20-Sep-23	MATHEW AIR	BELL429	2
12-Nov-23	MATHEW AIR	BELL429	2
13-Nov-23	MATHEW AIR	BELL429	2
18-Nov-23	MATHEW	BELL429	3
18-Nov-23	WHITESKY	EC-135T3H	1
19-Nov-23	WHITESKY	EC-135T3H	1
30-Nov-23	POLISI	AW169	8
01-Dec-23	POLISI	BELL429	8
02-Dec-23	POLISI	BELL429	8
02-Dec-23	POLISI	BELL429	8
02-Dec-23	POLISI	BELL429	8
03-Dec-23	POLISI	BELL429	8
03-Dec-23	POLISI	BELL429	8
05-Dec-23	POLISI	AW169	8
27-Deec-23	POLISI	AW169	8
14-Jan-24	MATHEW AIR	BELL429	2

helicopters use two parking stands as landing areas. Seeing the intensity of helicopter aircraft movements that often land at Kalimarau Airport, at least a separate heliport is needed outside the apron so that the apron can be used optimally for commercial flights. The number of helicopter aircraft landing is feared to damage the pavement on the top layer of the apron.

According to the Regulation of the Minister of Transportation Number 36 of 2021, article 22, paragraph 1, in order to support the safety of flight operations and airport services, every facility in the airport must meet the standards of necessity, technical, and feasibility. Therefore, to ensure flight safety from all possible risks, the airport should build Surface Level Heliport facilities with rigid pavement.

According to the Directorate General of Civil Aviation Regulation Number 215 of 2019 Technical and Operational Standards of Civil Aviation Safety Regulations Part 139 (Manual Of Standard Casr Part 139) Volume II Helicopter Landing and Takeoff Places (Heliport), Heliport is a place for takeoff and landing of helicopters on top of buildings (Elevated Heliport), on land (Surface Level Heliport), on offshore platforms/ships, and shipboard. Each manufacturer and operation of heliports must comply with the technical and operational standards set by the Directorate General of Civil Aviation manufacturing to achieve flight safety. One of the determinants of the achievement of work success in airport work is determined by the aspect of work planning.

The pavement planning to be used is required to accept and withstand the helicopter loads on it. Because of the relatively lower maintenance cost, resistance to overweight, infrequent loss of material, and adjustment of concrete weight to make all helicopter loads accepted with better distribution than flexible pavement so that it is more durable, the author chose to use rigid pavement in the planning of Surface Level Heliport.

This research aims to obtain the results of the planned helicopter rigid pavement construction calculations, with a bearing capacity that can support the helicopter load with the largest helicopter, the AW169 helicopter. The calculation method used is the FAA (Federal Aviation Administration) method in Advisory Circular No 150/5320-6D ‘Airport Pavement Design and Evaluation’ and using the FAARFIELD in Advisory Circular No 150/5320-6G ‘Airport Pavement Design and Evaluation’.

The problem formulation of the problem is as follows:

1. How to plan the thickness of surface-level heliport pavement that can carry the largest helicopter aircraft, type AW169, with maximum weight, at Kalimarau Airport, Berau?
2. What is the cost of implementing rigid pavement on Surface Level Heliport?

2. THEORETICAL BASIS

2.1. Heliport

According to Annex 14 Volume II 'Heliports' (fourth edition, 2013), a Heliport can be defined as an airfield or a specific area on a structure intended to be used for the arrival, departure and movement of helicopters on the surface.

Surface Level Heliports are the most commonly used helipads, placed on structures t that are on the water surface or above ground level. Helipads are generally constructed using concrete pavement and marked with the letter 'H' inside a circle or to be visible to pilots. Helipads are Marked with the letter 'H' inside a circle so pilots can see it from the air. From the air. In planning a helipad, it is important to consider the type of helicopter landing so that the weight and rotor diametres of the helicopter are known, environmental conditions, and markings.

2.2. The Specification of Helicopter

The Federal Aviation Administration (2023) 150/5390-2D about Heliport Design explains that in Surface Level Heliports at airports, complete specifications are needed, like helicopters in general, to plan the infrastructure.

The helicopter weight is useful for the pavement thickness and strength of the Surface Level Heliport planning. The Surface Level Heliport construction must withstand high landing loads due to engine failure with a shock coefficient of at least one-half of the Maximum Take-Off Weight of the largest helicopter in operation, with full fuel. The width and length of the helicopter affect the size of the Surface Level Heliport and the width of the land required to build the surface level.

2.3. Pavement Structure

Pavement is a structural arrangement consisting of several pavement layers with different hardness and bearing capacities. The pavement with high-quality aggregate bonded and asphalt is called flexible pavement, and pavement with a concrete slab is called rigid pavement.

Rigid pavement is pavement that is minimally deformed. So that its shape does not change even under loading. This pavement has several elements, namely a concrete slab, laid on a stabilized granular or subbase, supported by a compacted native layer called a subgrade. In some cases, a subbase may not be required. The following is an explanation of the rigid pavement arrangement.

The various materials below the subgrade must be compacted for stability and bearing capacity. Soil compaction can also increase the density of the soil, depending on the right mix of materials. he standard concrete pavement subbase material is P-154 subbase course 4 in (100 mm) thick. Projecting the values onto a concrete slab thickness graph is useful for determining the thickness of the concrete slab. The surface layer of the concrete is smooth, can retain water, and strengthens the structure with P-501 standard material.

Construction joints are joints used to connect 2 plates it also called a Dowel-type connection. A dowel is a connecting material between 2 (two) structural components. Dowels are in the form of plain or profiled steel bars, which are used as a means of connecting / binding to rigid pavement. Dowels function as load distributors in joints that are installed with half the length tied and half the length lubricated or painted to provide freedom of movement. Reinforced concrete structural components subjected to flexure must be planned to have sufficient stiffness to limit any deflection or deformation that could weaken the strength or reduce the serviceability of the structure under working loads.

2.4. FAA Manual Method

A manual method that uses a chart to determine each layer required, the method used is based on AC method No. 150/5320-6D: 150/5320-6D. It can be defined by plotting the EAD, flexural strength, and CBR data of the soil.

2.5. FAARFIELD

FAARFIELD is a proprietary FAA application to calculate flexible and rigid pavements in aircraft movement areas. The calculation method is based on FAA-AC No:150/5320-6G. FAARFIELD is built using concepts such as Cumulative Damage Factor (CDF) and can easily obtain results such as maximum gross weight more efficiently and simply by inputting numbers.

2.6. COMFAA

COMFAA is a computer software to determine PCN values and calculate the maximum permissible gross weight, especially in the aspects of the calculation stages and interpretation of the software output. In use, the software is supported by an additional tool in the form of Ms. Excel Spreadsheet to know the value of equivalent thickness, which will be explained further in this module. The software and spreadsheet can be accessed freely through the official website of the United States Federal Aviation Administration (FAA).

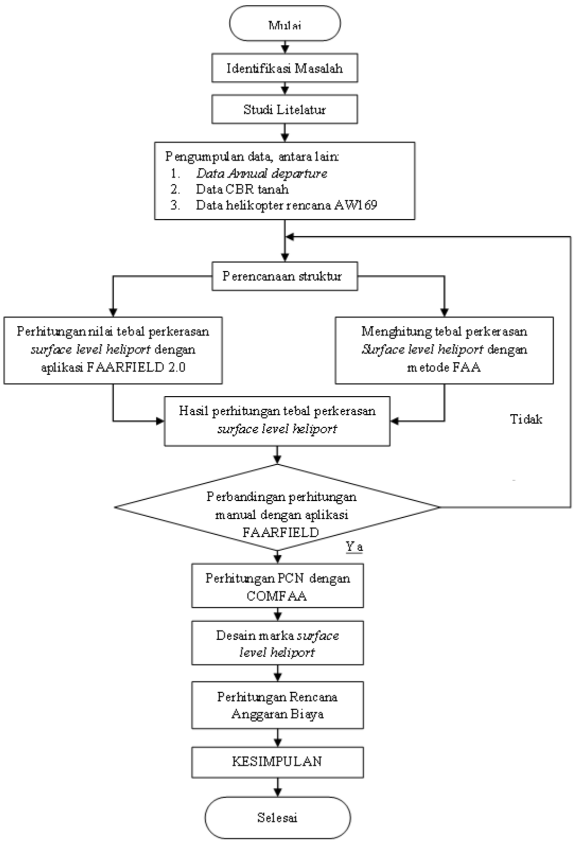
Aircraft Classification Number/Pavement Classification Number is an ICAO-defined, no-alternative method for assessing the strength of concrete or asphalt pavements at airports. The method can determine the impact of aircraft on pavement by using a range of numbers in its definition. The helicopter uses the maximum allowable gross weight and the following is a display of the program used to determine the maximum allowable gross weight.

2.7. Marking Design of Heliport

In Federal Aviation Administration (2023) 150/5390-2D on Heliport Design regarding this design Standard, there is no more than one helicopter in one place unless each helicopter is spaced according to its respective safety area.

3. RESEARCH METHODS

This research uses a quantitative method by analyzing a problem based on standard theories described in the field. This method is included in descriptive analysis, which means that the information in the analysis is collected based on symptoms at the time of research. The stages carried out in this research process are described through a flowchart as follows :



The data was collected during On the Job Training activities at Kalimarau Airport Berau.The material used from several sources, including:

1. Federal Aviation Administration (2021) Advisory Circular 150/5320-6G tentang *Airport Pavement Design and Evaluation.*
2. Keputusan Pemerintah No 93 Tahun 2015 – *Pedoman Teknis Operasional dan Perhitungan PCN*.
3. ICAO Annex 14, Aerodrome, 2013.
4. Federal Aviation Adminitration (2023). Advisory Circular 150/5390-2D tentang *Heliport Design*.

The data collection process is intended to obtain information on the problems that occur, and it can be used to finish the problem. Data collection is carried out in two stages, it can occur by direct observation and analysis of data directly related to Kalimarau Berau Airport. Direct observation to the location and data collection was carried out during the implementation of On the Job Training at Kalimarau Airport Berau.Collection of current or existing airport data as supporting data for the implementation of the work. Starting from land data, aircraft movement data, and types of aircraft operating.

The research process starting from the preparation stage, data collection, and data processing stage was carried out during the 2nd on the job training (OJT) in October 2023 - February 2024. The data collection stage such as helicopter movement data and California Bearing Ratio (CBR) data. The writing stage was carried out from February to July.

4. RESULTS AND DISCUSSION

4.1. The Specification of Helicopter

The Federal Aviation Administration (2023) 150/5390-2D about Heliport Design explains that in Surface Level Heliports at airports, complete specifications are needed, like helicopters in general, to plan the infrastructure.

Table 1. *Largest Helicopter*

Largest Helicopter The Agusta Westland AW169		
Description	Specifications	
TotalLength (D)	48.1 feet	14.65 m
Helicopter Body Length	40 feet	12.19 m
Main Propeller Diametres (RD)	39.7 feet	12.12 m
Maximum Take-off Weight *(B)*	10141 lb	4600 kg
Crew	1-2 orang	
Passanger	8-10 orang	
Height	14.7 feet	4.50 m

4.2. Dimension Planning of Surface Level Heliport

The Surface Level Heliport must be able to serve the largest helicopter, AgustaWestland AW169. This is so that the apron does not become damaged and can be used optimally by aircraft land, helicopters can freely take off and land at Kalimarau Berau Airport.

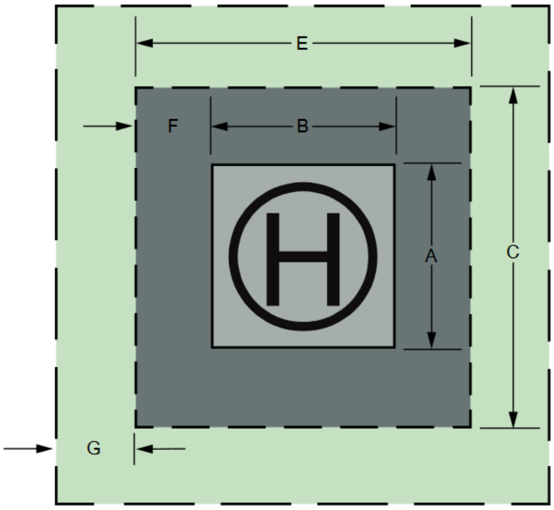


Figure 1 *Helicopter Movement Area*

Table 2. *Largest Helicopter*

Dimension	Item	Value
A	Minimum TLOF Length	13 metres
B	Minimum TLOF WIDTH	13 metres
C	Minimum FATO Length	22 metres
D	Panjang Total Helikopter	14.65 metres
E	Minimum FATO Width	22 metres
F	Separation between TLOF and FATO perimetres	5 metres
g	Safety Area Width	7 metres

The dimensions of the helicopter have already been determined. The dimensions of the landing and lifting area are 13 m x 13 m equal to 169 m2. The length of the final approach and take-off area is 22 m on each side. The length of the safety area is 37 m.

Helicopters have a wide range of wheel configurations and loading. These can significantly affect the condition of the pavement. The greater the load transmitted by the helicopter to the wheels, the greater the load received by the pavement. The number of wheels on the helicopter affects the distribution of the helicopter's load. Helicopters with the same load, but different wheel configurations have different impacts. The fewer helicopter wheels, the greater the risk of damage to the pavement.

4.3. Calculate the Annual Departure Data

The calculation of helicopter departures operating at Kalimarau Airport Berau - East Kalimantan, will be converted into helicopter landing gear. So, it can be considered that only the most critical helicopter aircraft land at the airport.

The Annual Departure Equivalent calculation results will be projected onto the pavement thickness chart. The calculation of the annual departure equivalent for AW169 helicopter aircraft operating at Kalimarau Airport Berau - East Kalimantan is as follows.

LogRI =(LogR2)*(W2/W1)^(1/2)

RI = 〖10Log〗 ^(Log R2×(w2/w1)^(1/2))

AW169 = Log R1 = Log 5 $(10141/10141)^{1/2}$ = 5

BELL429 = Log R1 = Log $17(7000/10141)^{1/2}$ = 11

EC135 = Log R1 = Log $3(5798/10141)^{1/2}$ = 3

EC130 = Log R1 = Log $3(5511/10141)^{1/2}$ = 3

BELL407 = Log R1 = Log $3(5250/10141)^{1/2}$ = 3

Table 3. equivalent annual departure

Jenis Helikopter	*Annual Departure*	MTOW (pounds)	*Annual Dep Konv*	*EAD*
			R2	RI
AW169	5	10141	5	5
BELL429	17	7000	17	11
EC-135T3H	3	5798	3	3
EC-130B4	3	5511	3	3
BELL 407GX	3	5250	3	*3*
TOTAL	**31**			25

The total equivalent annual departure is 25. This number will be projected into the pavement thickness chart.

4.4. Calculate the Surface Level Heliport pavement thickness using FAA manual method

The construction strength of the heliport is determined by knowing the strength of the subgrade, subbase, stabilized base, and rigid pavement construction to be planned. The building should support the static load of an Agusta Westland AW169 helicopter with a weight of 10141 lbs. K-350 is used in the planning to withstand these loads. Wire mesh is used to support flexural strength. The recommended value of flexural strength is between 600-750 psi and 650 psi is the chosen one. Wiremesh was used for support.

4.4.1. Subgrade

The formula used to convert CBR values into subgrade reaction modulus values is as follows:

$k = (1500/26 \times \text{CBR})^{0.7788} = k$ pci
(AC 150/5320-6D)
k = Modulus reaction of subgrade
The field soil CBR value is 6.68%. Based on this data, the value of k, is:
$k = (1500/26 \times 〖6.68)^{0.7788} = 103.25$ pci ≈ 103 pci

4.4.1. Subbase

Subbase thickness can be defined by adjusting the MTOW of the AW169 helicopter aircraft to the minimum layer thickness table for rigid pavement structures. Provided that the subbase CBR value is > 25%, a subbase of 25% is used. The k value of the subbase is :

$k = [(1500 \times 25)/26]^{0,7788} = 288.5854 \approx 289$ pci

The graphic projection of the K Subgrade = 103 pci and K Subbase = 289 pci values can be seen as follows.

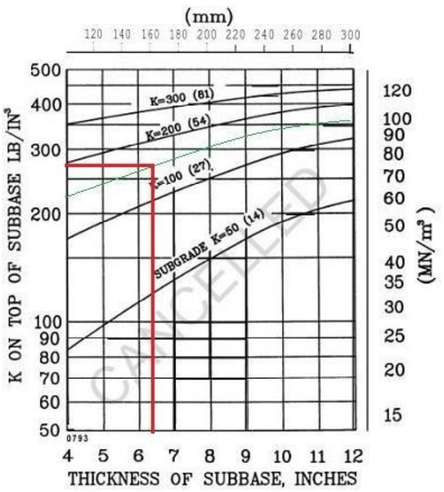


Figure 2 *The graphic projection.*

According to Doc AC No 150/5320-6D by using existing data the minimum subbase thickness can be found, which is 6.4 inch or 17 cm. The minimum subbase thickness is used as a safety value in thick planning.

4.4.2. Surface

To determine the thickness of a concrete slab on a rigid pavement project the value onto the concrete slab thickness chart.

MR = K x $\sqrt{}$(fc'^)

MR = Flexural Strength/Modulus of Rupture

K = constant (values 8,9,10)

Fc' = Concrete compressive strength (Psi)

Planning uses concrete with a grade of K-350 = 4206 Psi and a value of k = 10. With this data, the flexural strength value can be obtained, which is:

$MR = 10\sqrt{4206} = 648.54$ Psi ≈ 650 Psi

The first step is to project the MR value of 650 psi, and draw it to the subbase k value of 289 pci, then draw the line again to the pavement thickness value according to the equivalent annual departure year, 25. In this way, the thickness of the concrete slab can be found to be 6 inches or 15.24 cm ≈ 16 cm.

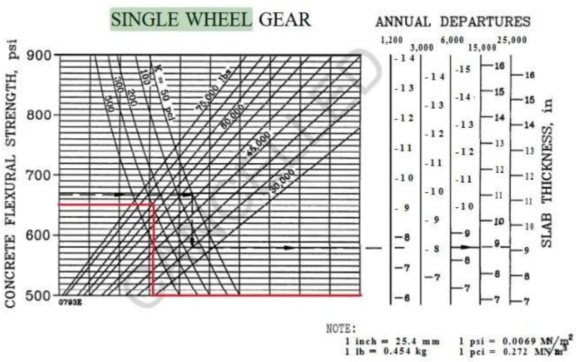
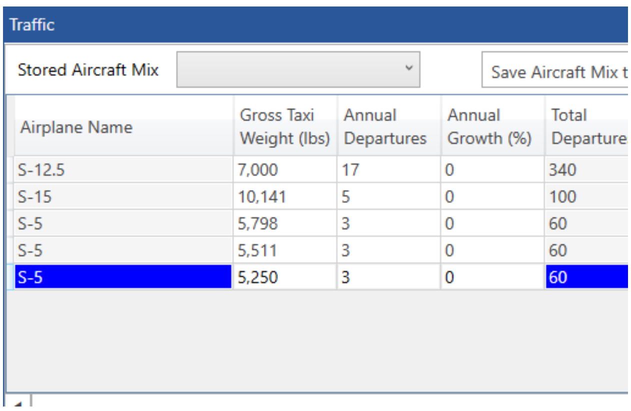


Figure 3 *surface graphic projection*



Airplane Name	Gross Taxi Weight (lbs)	Annual Departures	Annual Growth (%)	Total Departure
S-12.5	7,000	17	0	340
S-15	10,141	5	0	100
S-5	5,798	3	0	60
S-5	5,511	3	0	60
S-5	5,250	3	0	60

Figure 4 *Surface graphic*

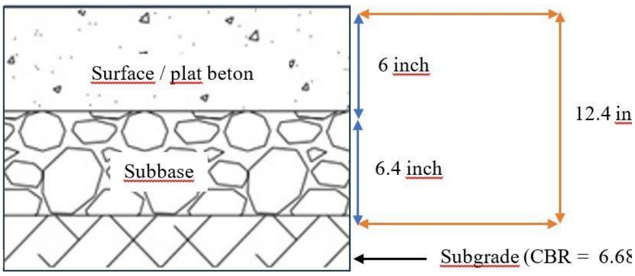


Figure 5 *Concrete pavement thickness plan*

The pavement thickness using FAARFIELD application based on Advisory Circular AC No.150/5320-6D is as follows:

Subgrade K value = 103 pci = 34.2 〖MN/m〗^3

Thickness of sub-base (P-154) = 16 cm = 6 inch

surface thickness (P-501) = 17 cm = 6.4 inch

Flexural Strength = 650 psi = 4.48 Mpa

4.5. Calculate the Surface Level Heliport pavement thickness using FAARFIELD

The FAARFIELD program is the tools to design the pavements, especially rigid pavements. The procedure of using FAARFIELD is basically as follows.

1. Click the ‘New Job’ command in the FAARFIELD application, then input the ‘Job name’ and ‘section name’ as needed. The pavement type is changed to ‘New Rigid’.

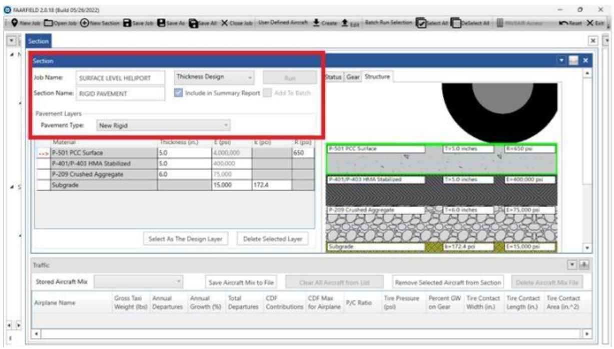


Figure 6 *FAARFIELD 2.0.18*

2. The planned helicopter aircraft weighs less than 60,000 lbs, therefore the layers used do not require a Stabilised base and base. Subgrade strength from Kalimarau Airport data is 6.68%, for K value can be known by using the formula from Ac No.150/5320-6G:

$$K = 28.6926 \text{ x } CBR^{0.7788}$$

$$K = 28,6926 \text{ X } 6.68^{0.7788}$$

$$K = 125.923 \text{ pci} \approx 126 \text{ pci}$$

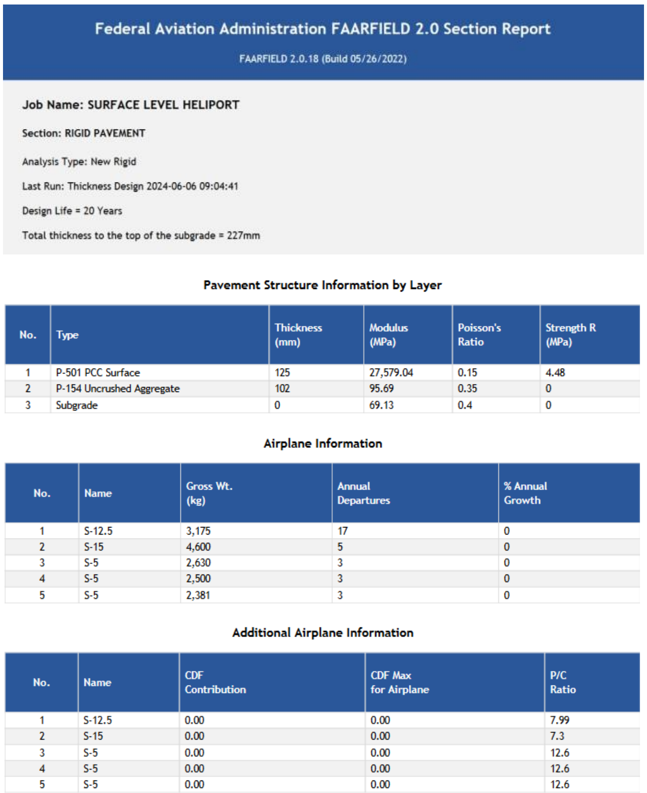
3. Input helicopter that operates

Select the ‘Airplane’ tab on the bottom left. Then enter the operating aircraft data, and annual departure data, along with the MTOW of each helicopter aircraft.

Figure 7 *the annual departure of helicopter*

4. Result of thickness plan

Once all data is entered, such as Annual Departure data, pavement type, helicopter aircraft, and existing subgrade strength. The pavement thickness can then be defined with the FAARFIELD application.



Federal Aviation Administration FAARFIELD 2.0 Section Report

FAARFIELD 2.0.18 (Build 05/26/2022)

Job Name: SURFACE LEVEL HELIPORT

Section: RIGID PAVEMENT

Analysis Type: New Rigid

Last Run: Thickness Design 2024-06-06 09:04:41

Design Life = 20 Years

Total thickness to the top of the subgrade = 227mm

Pavement Structure Information by Layer

No.	Type	Thickness (mm)	Modulus (MPa)	Poisson's Ratio	Strength R (MPa)
1	P-501 PCC Surface	125	27,579.04	0.15	4.48
2	P-154 Uncrushed Aggregate	102	95.69	0.35	0
3	Subgrade	0	69.13	0.4	0

Airplane Information

No.	Name	Gross Wt. (kg)	Annual Departures	% Annual Growth
1	S-12.5	3,175	17	0
2	S-15	4,600	5	0
3	S-5	2,630	3	0
4	S-5	2,500	3	0
5	S-5	2,381	3	0

Additional Airplane Information

No.	Name	CDF Contribution	CDF Max for Airplane	P/C Ratio
1	S-12.5	0.00	0.00	7.99
2	S-15	0.00	0.00	7.3
3	S-5	0.00	0.00	12.6
4	S-5	0.00	0.00	12.6
5	S-5	0.00	0.00	12.6

Figure 8 *pavement thickness using FAARFIELD*

The pavement thickness using FAARFIELD application based on Advisory Circular AC No.150/5320-6G is as follows:

Subgrade K value = 126 pci = 34.2 〖MN/m〗^3

Thickness of sub-base (P-154) = 10.2 cm = 4 inch

surface thickness (P-501) = 12.5 cm = 5 inch

Flexural Strength = 650 psi = 4.48 Mpa

4.6. determination of the pavement thickness to be used

FAARFIELD was the method that will be used. This is because the thickness required to carry out pavement thickness planning is smaller. With these results, it can be concluded that by using FAARFIELD the material requirements and costs become more efficient.

The latest Airport Pavement Design and Evaluation regulation issued by the FAA is Advisory Circular

150/5320-6G which uses the FAARFIELD in determining pavement thickness. The manual FAA method is no longer relevant to the latest regulations. The manual method is available in Advisory Circular 150/5320-6D, which has been cancelled along with the legalised of Advisory Circular 150/5320-6G.

4.7. Planning Maximum Permissible Gross Weight with COMFAA Application

Input material to the Excel as follows

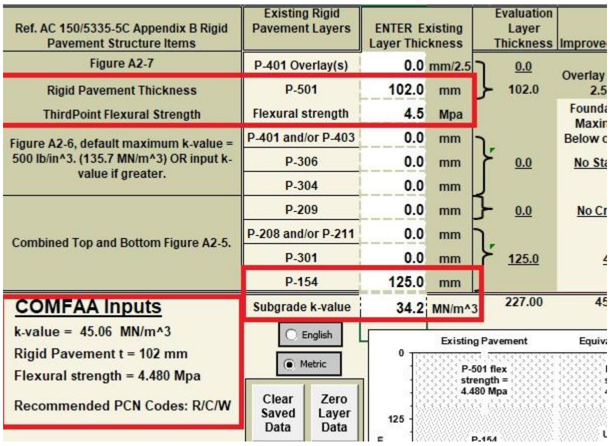
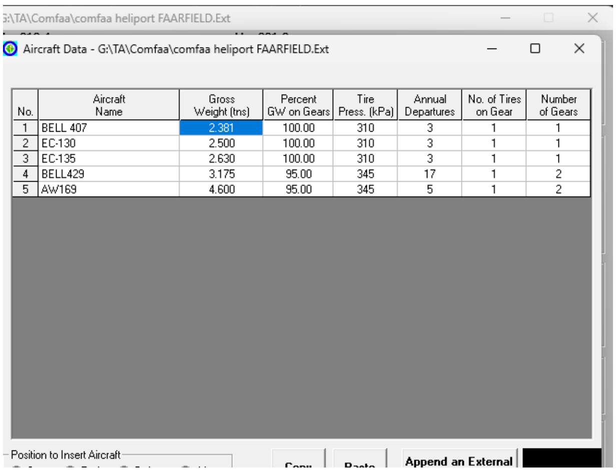


Figure 9 *COMFAA Spreadsheet*

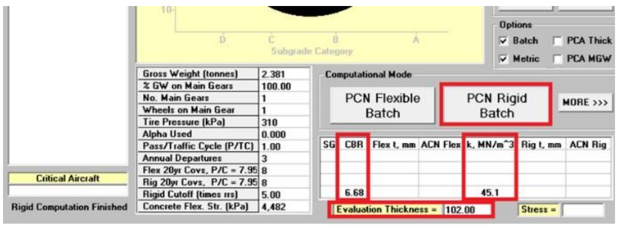
After entering the data into the spreadsheet, the data in the 'COMFAA Inputs' column is entered into the COMFAA application. The first step is to enter the annual departure data of existing helicopter aircraft by selecting the 'Open Aircraft Windows' command.



No.	Aircraft Name	Gross Weight (tns)	Percent GW on Gears	Tire Press. (kPa)	Annual Departures	No. of Tires on Gear	Number of Gears
1	BELL 407	2.381	100.00	310	3	1	1
2	EC-130	2.500	100.00	310	3	1	1
3	EC-135	2.630	100.00	310	3	1	1
4	BELL429	3.175	95.00	345	17	1	2
5	AW169	4.600	95.00	345	5	1	2

Figure 10 *airport window COMFAA*

Input CBR, *k*, and evaluation thickness to COMFAA



Select the 'PCN Rigid Batch' command in the Computational Mode. Wait a few moments for the COMFAA application to calculate the data. After the running process is complete, the data can be seen in the 'Details' command. It occurs many data such as PCN, ACN, and Maximum Allowable Gross Weight data.

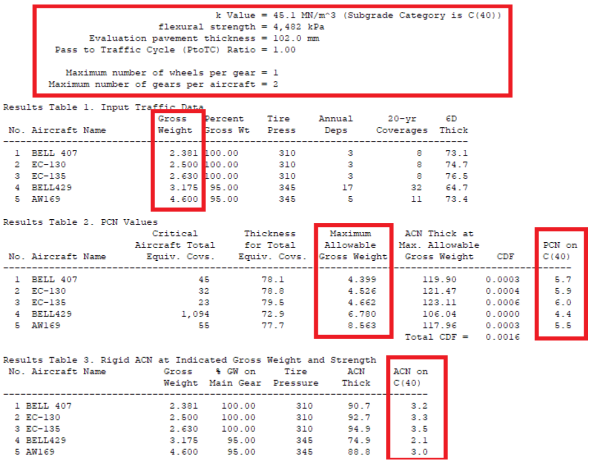


Figure 11 *The result from COMFAA*

From COMFAA, the PCN value is 6.0 and the Maximum Allowable Gross Weight is 8,563 metric tonnes. In other words, a more critical heliport could use a planned heliport with a maximum weight of 8,563 metric tonnes or 8563 kilograms.

4.7. Dowel Bar

The thickness of the slab obtained through FAARFIELD calculation is 5 inch, to be converted into the table according to Advisory Circular AC No: 150/5320-6G, dowels with a diametres of 22 mm, a length of 46 cm and a distance of 30.5 cm between dowels are used, according to the assumed thickness.

4.7. Reinforcement Calculation for Rigid Pavement

1. The formula used to determine the reinforcement required for rigid pavement is:

ØMn = As.fy.{D - $(a/2)$}.09

ØMn = Moment value

As = the area of transverse reinforcement installed on each slab

Fy = Yield stress

D = Effective height

a = equivalent square stress block height

2. The value of the cross-sectional area is :

As = (0.25 x π x d^2 x 1000 mm)/ distance between dowels

As = (0.25 x 3.14 x 6^2 x 1000 mm)/150

As = 188.4 m^2

3. Steel grade 550 Mpa

4. the value of square tension block height

a = as x fy /(0.85 x f'c x 1000)

a = 188.4 x 550 / 0.85 x 38 x 1000

a = 3.2 mm

5. The value of momen

ØMn = As.fy.{D – $(a/2)$}.09

ØMn = 188.4 x 550 (167 – 3.2/2) 0.9

ØMn = 1.0367 x 10^5 x 165.3 x 0.9

ØMn = 1.5432 x 10^7 KNmm

ØMn = 1.5432 x 10^4 KNm

Source : SNI 2847:2019

Through the calculations that have been carried out, the wire mesh that is planned is M6-15 cm wire mesh.

4.7. surface level heliport

To fulfill international standards, technical and operational standards must improve flight safety. Thus, the planning of Surface Level Heliport marking with KP 215 of 2019 on Technical and Operational Standards of Civil Aviation Safety Regulations Part 139 (Manual of Standard CASR part 139) Volume II is used as a guideline in planning.

The width of the letter H is 2 m. The diametres of the circle is 8.4 m. The dimension of the touchdown and lift of area is 13 m x 13 m equals 169 m2. The final approach and take off area length is 22 m in every side. The safety area length is 37 m.

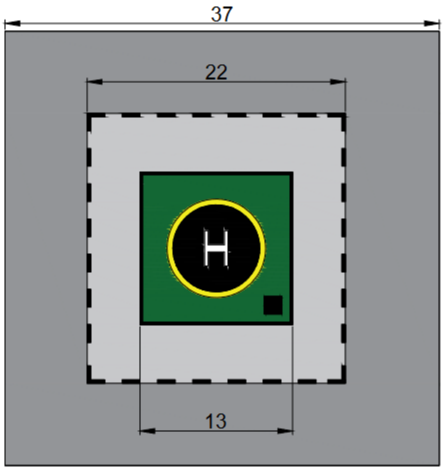


Figure 12 *surface level heliport markings.*

4.8. Cost Budget Plan

The calculation of pavement thickness and PCN is required to determine the draft cost budget. The results of planning the thickness of the Heliport using rigid pavement become the main point in calculating the volume of work, taking into account each layer of pavement plan to become the total material needed to carry out the Surface Level Heliport planning work.The cost Budget Plan is to know the cost of materials, wages, and other costs related to the building or project required in the planning. The results of the Surface Level Heliport volume planning work are summed up by the prices of services around the Berau region - East Kalimantan. From the calculated RAB, the costs required to carry out Surface Level Heliport construction at Kalimarau Airport Berau - East Kalimantan can be obtained.

URAIAN PEKERJAAN	VOLUME	SAT.	BIAYA SATUAN UKUR		JUMLAH
2	3	4	5		6
PEKERJAAN PEMBERSIHAN	1,370.00	m2	133,600.66	Rp	183,032,909.00
PEKERJAAN PENGUKURAN	1,369.00	m2	14,578.09	Rp	19,957,405.21
MOBILISASI DAN DEMOBILISASI	2.00	Ls	2,342,435.00	Rp	4,684,870.00
PEKERJAAN BEKISTING	139.86	m2	387,028.13	Rp	54,129,754.26
BETON SEMEN BERTULANG MUTU K-350	310.76	m3	2,776,598.53	Rp	862,864,087.42
PEKERJAAN WIREMESH	4,207.00	kg	35,252.91	Rp	148,308,971.34
PEMBESIAN DOWEL	877.00	kg	144,869.87	Rp	127,050,875.99
PEKERJAAN MARKING	484.00	m2	70,463.43	Rp	34,104,301.33
	SUB TOTAL			Rp	1,434,133,174.55
	PPN 11%			Rp	157,754,649.20
	GRAND TOTAL			Rp	1,591,887,823.75
	PEMBULATAN			Rp	1,591,888,000.00

5. CONCLUSION AND SUGGESTIONS

5.1. Conclusion

Based on the data that has been processed, analyzed, and calculated, the conclusions can be explained as follows:

The results of Surface Level Heliport pavement thickness using FAARFIELD and COMFAA have been calculated. The surface layer has 12.5 cm of thickness. The subbase layer has 10.2 cm of thickness. The CBR value for the subgrade is 6.68%. the ACN value is 3.5 and the PCN value is 6. The maximum gross weight helicopter for the heliport is 8.563 matrix tons.

FAARFIELD was the method that will be used. This is because the thickness required to carry out pavement thickness planning is smaller. With these results, it can be concluded that by using FAARFIELD the material requirements and costs become more efficient.

The results of the Surface Level Heliport marking plan calculation is 37 m x 37 m x 0.227 m, based on AC No. 150/5390-2D. The width of the letter H is 2 m. The diametres of the circle is 8.4 m. The dimension of the touchdown and lift of area is 13 m x 13 m equals 169 m^2. The final approach and take off area length is 22 m in every side. The safety area length is 37 m.

After knowing the thickness of the pavement layer and markings of the Surface Level Heliport, we continue to calculate the Draft Budget Cost to realize the estimated budget needed to work on the manufacture of Surface Level Heliport. The total budget required from the description of the Surface Level Heliport according to East Kalimantan Government Regulation No. 24 of 2023 is Rp. 1,591,888,000 (Said to be One Billion Five Hundred Ninety-One Million Eight Hundred Eighty-Eight Thousand Rupiah).

5.2. Suggestions

For Further research using the Cost Budget Design is recommended to use unit prices from the most recent rules or regulations owned by the local government of Kalimarau Berau Airport and the cost can be even more relevant than the original price in the field. The current research calculates the pavement thickness, marking, and cost budget design. For future research, it can be done by considering the reinforcement structure of the pavement thickness so that the research can be better.

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