PLANNING SURFACE LEVEL HELIPORTAT LABUAN BAJO KOMODO AIRPORT

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ABSTRACT

Komodo Airport has a runway with dimensions of 2,650 m x 45 m and a PCN value of 55 F/C/X/T. The airport also has two aprons, apron A measuring 220 x 100 m with an asphalt surface, and apron B measuring 91 x 100 m with a rigid surface. As Komodo Airport is strategic and growing rapidly, a plan for the construction of a Surface Level Heliport has been developed using Annual Departure data and determination of helicopter plans. The development is planned with dimensions of 32 x 32 m for the largest helicopter, SUPER PUMA, with a budget of Rp 1,475,170,512. (one billion four hundred seventy-five million one hundred seventy thousand five hundred twelve rupiah).

Keywords: Surface Level Heliport, Rigid Pavement, FAA Method, FAARFIELD, COMFAa

1. INTRODUCTION

Komodo Airport is located in Labuan Bajo, East Nusa Tenggara, and is part of the Directorate General of Civil Aviation. With a 2650 m long and 45 m wide runway, the airport plays an important role in the growth of the local economy. Originally named Mutiara II Airport, its handover to the Ministry of Transportation took place in 1993, and since then the airport has undergone various developments to allow large aircraft to land and take off.

In 2021, the runway was 2250m long, but was extended in 2022 to 2650m, allowing aircraft characterised by the A320-800 and B737-900ER to land. In addition, there are two aprons with appropriate dimensions and PCN values to assist operations. Komodo Airport is also equipped with two taxiways to facilitate aircraft movement in the airport area. However, there is currently no heliport facility at Komodo Airport, although the airport serves as a home base for various types of helicopters .

The quality and construction of the helipad is very important to support helicopter operations. The airport is committed to providing maximum services according to the standards set by the Directorate General of Civil Aviation, ensuring safety and comfort in every flight.

According to the Directorate General of Civil Aviation (2015b), every airport facility must meet safety standards to support flight operations. One of these efforts is to provide a Surface Level Heliport that uses rigid pavement to support helicopter loads. Rigid pavement was chosen due to its low maintenance cost and its ability to adjust to the heavy load of helicopters, such as Super Puma, which will be evenly distributed. This research aims to formulate rigid pavement calculations based on the FAA method. The author raises the Final Project title ‘Surface Level Heliport Planning at Komodo Labuan Bajo Airport’ to discuss this matter.

Based on the background of the problem as described above, the following problem formulation is obtained:

1. How to plan the thickness of rigid pavement on Surface Level Heliport that can carry the largest type of helicopter aircraft at Komodo Airport?
2. What is the Budget Plan for the planning of Surface Level Heliport at Komodo Airport?

2. THEORETICAL FOUNDATIONS

2.1 Heliport

A heliport is a place for helicopter take-off and landing, which includes several types, namely:

This standard is governed by civil aviation regulations.

1. Surface Level Heliport
   Surface Level Heliport: Located at ground or water level, usually made of concrete with an ‘H’ mark for visibility from the air. Planning requires attention to helicopter type, weight, and environmental conditions.
2. Elevated Heliport
   Elevated Heliport: Located above a building structure
3. Helideck
   Helideck: Found on fixed or floating facilities, often used for oil and gas exploration.
4. Shipboard Heliport
   Shipboard Heliport: Located on a ship, may be designated for helicopter operations or non-purposed using areas that support but are not specifically designed for them.

2.2 . Flexible Pavement

Flexural pavement is a structure built through a process of overlaying from the surface to the subgrade, as per SKEP/003/I/2005. Its stability depends on aggregate locking, particle friction and cohesion with a defined layer structure.

1. Subgrade
   Subgrade in pavement thickness planning will determine the quality of pavement construction so that the properties of the subgrade determine the strength and durability of the construction.
   There are various methods used to determine the bearing capacity of subgrade soils, ranging from simple to complex methods such as CBR (California Bearing Ratio), MR (Modulus of Elasticity), and K (Modulus of Subgrade Reaction).
2. *Sub Base Course*
   The sub base course is the structure of flexible pavement construction that lies between the sub grade and the base course. The total thickness of the pavement layer obtained after using the equivalent factor shall not be less than the total thickness of the pavement layer required by the standard material and the subgrade CBR value of 20%. The sub base layer should be compacted such that the CBR value is at least 20%, and preferably more than 20% to ensure the efficiency of the layer.
3. *Surface Course*
   Surface course is the layer that is on the topmost surface.

2.3 Rigid Pavement

Rigid pavement is a pavement that has the characteristics When loading occurs the pavement does not change shape meaning that the pavement remains in its original state before loading.

Rigid pavement consists of a concrete slab, which is placed on a stabilised granular layer or subbase, supported by a compacted native layer called subgarede. Under certain conditions, sometimes a subbase is not required. The explanation of the rigid pavement structure is:

1. Subgrade
   Subgrade materials under rigid pavements must be compacted to achieve adequate stability and uniform support. Proper compaction, taking into account the moisture content, will increase the density as well as the strength of the subgrade. The FAA recommends that cohesive soils used for backfill be compacted to 90% of maximum density, while non-cohesive soils should be compacted to 100% for the top layer and 95% for other layers. This compaction process must follow certain test procedures to ensure the quality and strength of the subgrade.
2. *subbase course*
   The standard concrete pavement subbase material is P-154 subbase course 4 in (100 mm) thick. On new pavements that will be used by 100,000 lb (45,400 kg) aircraft, the lower foundation layer needs to be stabilised.
3. Concrete
   According to (Basuki, n.d.) (1986) in the book Designing Airfield Planning explains the concrete surface layer must provide a flat surface, keep surface water from entering and provide structural support. The standard material category is P-501 Cement concrete pavement.
   To plan the thickness of concrete slabs in rigid pavements, it is necessary to project the values obtained into a concrete slab thickness calculation chart. This process also includes the determination of (Flexural Strength) using Eq.

$$MR = K x \sqrt{(fc'\hat{}\ )} \quad ....(1)$$

Where: MR = Flexural Strength

K = constant (value 8,9,10)

fc' = Concrete compressive strength (Psi)

2.4 FAA Manual Method

Pavement thickness planning can be done by manually analysing based on a graphical method (FAA 150/5320-6D, 1978). The calculation step begins by processing relevant data such as subgrade strength, calculating equivalent Annual Departure, and determining flexural strength which is then projected onto a graph. From the graph, the required subbase thickness and concrete slab thickness can be determined to ensure the required pavement strength and durability, as shown in the figure below.

Figure 2.1 Subbase Thickness Calculation Chart

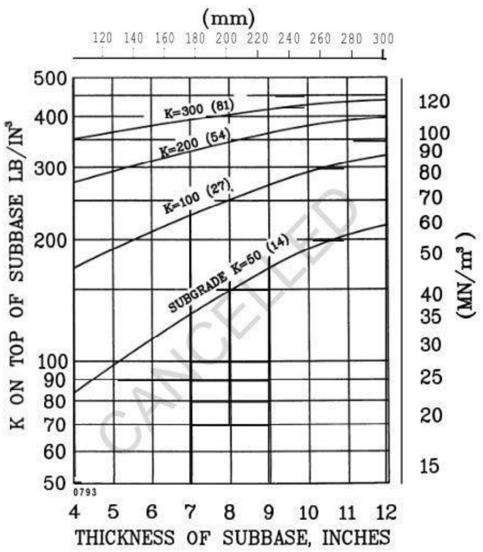


Figure 2.2 Concrete Slab Thickness Calculation Chart

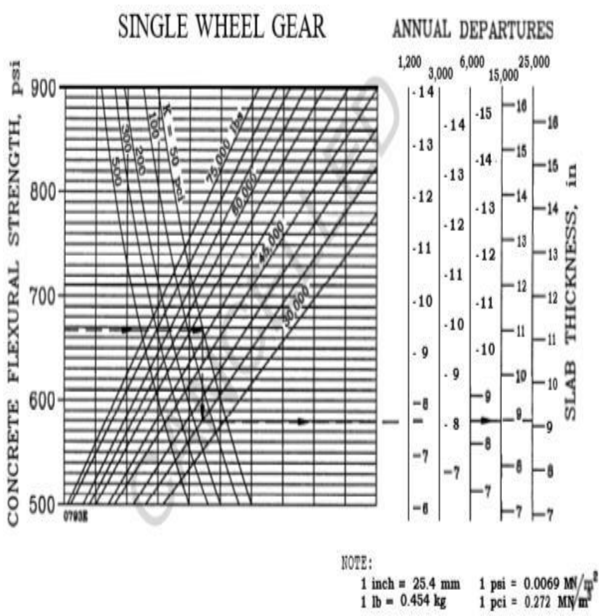
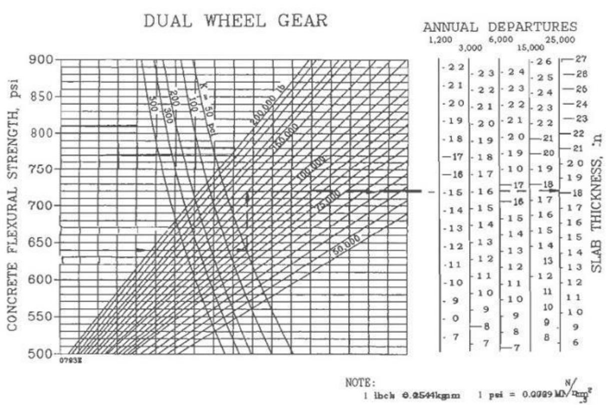


Figure 2.3 Dual Wheel Gear Concrete Slab Thickness Calculation Chart

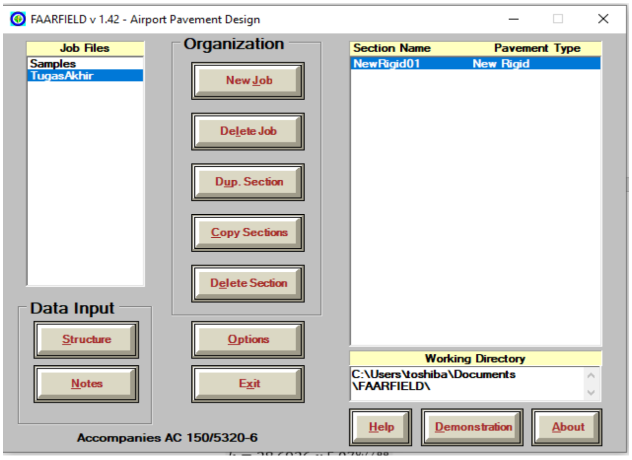


The FAA method was introduced in 1968 and evolved until 1978, with the latest edition of the Department of Transportation Federal Aviation Administration DC on runway pavement layer design. This method is recognised by the International Civil Aviation Organization (ICAO) in its aerodrome manual. Helipad pavements generally use rigid pavements to resist static loads during helicopter refuelling. The development of this FAA method is contained in Advisory Circular Airport Design and Evaluation AC no. 150/5320-5E.

2.5 SOFTWARE FAARFIELD

FAARFIELD (Federal Aviation Administration Rigid and Flexible Iterative Elastic Layered Design) is a computer programme for designing the thickness of flexible and rigid pavements on runways, heliports, taxiways and aprons.

Figure 2.4 FAARFIELD App View

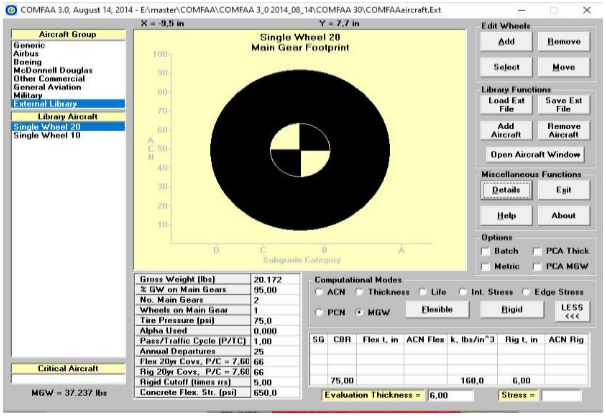


FAARFIELD applies an elastic layer procedure and finite element planning to new flexible and rigid pavements. FAARFIELD is based on the concept of Cumulative Damage Factor (CDF) and can also determine the maximum allowable gross weight with input.

2.6 Comfaa

The ACN/PCN system is the only method applied by ICAO (International Civil Aviation Organisation) to rate the performance/strength of airport pavements. Using this method, the impact/damage caused by a helicopter can be replaced by a number called ACN (Aircraft Classification Number). Conversely, the capacity/strength of a pavement can also be replaced by a number without the need to present the type of helicopter and detailed information about the pavement structure. This number is called PCN (Pavement Classification Number). For helicopters, the maximum allowable gross weight is used and the following is a view of the programme used to determine the maximum allowable gross weight value.

Figure 2.5 Comfaa App View



COMFAA is a computer programme used to determine PCN values and can also calculate the maximum allowable gross weight, especially in aspects of the calculation stages and interpretation of the output of the programme. In its use, this programme is supported by additional tools in the form of Ms. Excel Spreadsheet for the determination of equivalent thickness which will be explained further in this module. The programme and spreadsheet are freely accessible through the official website of the United States Federal Aviation Administration (FAA). In determining the PCN value with the COMFAA programme in accordance with the procedures and principles detailed in the latest standard published by the FAA in 2014, namely Advisory Circular/AC 150/5335-5C.

2.7 Concrete Slab

Reinforced concrete slab is a thin structure made of reinforced concrete with a relatively small thickness compared to its long span. Its main function is as a diaphragm or reinforcing element in buildings. Floor slabs, which are part of the building structure, function as separators between levels and are supported by beams and columns. Apart from buildings, floor plates are also used in other structures such as bridges and harbours. The floor plate first receives the load before transferring it to the rest of the structural frame system.

Plate construction is an element of the building structure that directly supports the live load in accordance with the function of the building, as well as additional dead loads which are also known as (superimposed dead loads).

1. A one-way plate

A one-way plate is a slab supported by beams on two opposite sides to carry the load along one direction. The ratio of longer span (l) to shorter span (b) equal to or greater than 2, is considered as a one-way plate as this slab will bend in one direction i.e. in the direction along the shorter span.

Due to the huge difference in length, the load is not transferred to the shorter beam. Main reinforcement is provided in the shorter span and distribution reinforcement in the longer span.

Figure 2.6 A one-way plate

Komponen struktur	Tebal minimum, *h*			
	Tertumpu sederhana	Satu ujung menerus	Kedua ujung menerus	Kantilever
	Komponen struktur tidak menumpu atau tidak dihubungkan dengan partisi atau konstruksi lainnya yang mungkin rusak oleh lendutan yang besar			
Pelat masif satu-arah	**ℓ / 20**	**ℓ / 24**	**ℓ / 28**	**ℓ / 10**
Balok atau pelat rusuk satu-arah	**ℓ / 16**	**ℓ / 18,5**	**ℓ / 21**	**ℓ / 8**

CATATAN:
Panjang bentang dalam mm.
Nilai yang diberikan harus digunakan langsung untuk komponen struktur dengan beton normal dan tulangan tulangan Mutu 420 MPa. Untuk kondisi lain, nilai di atas harus dimodifikasikan sebagai berikut:
(a) Untuk struktur beton ringan dengan berat jenis (*equilibrium density*), w_c, di antara 1440 sampai 1840 kg/m^3, nilai tadi harus dikalikan dengan **$(1{,}65 - 0{,}0003w_c)$** tetapi tidak kurang dari 1,09.
(b) Untuk f_y selain 420 MPa, nilainya harus dikalikan dengan **$(0{,}4 + f_y/700)$**.

2. A two-way slab

A two-way slab is a slab that is supported by beams on all four sides and loads are imposed by the supports in both directions. In a two-way slab, the ratio of the longer span (l) to the shorter span (b) is less than 2.

In a two-way slab, the load will be carried in both directions. So, main reinforcement is provided in both directions for a two-way slab.

Figure 2.7 A two-way slab

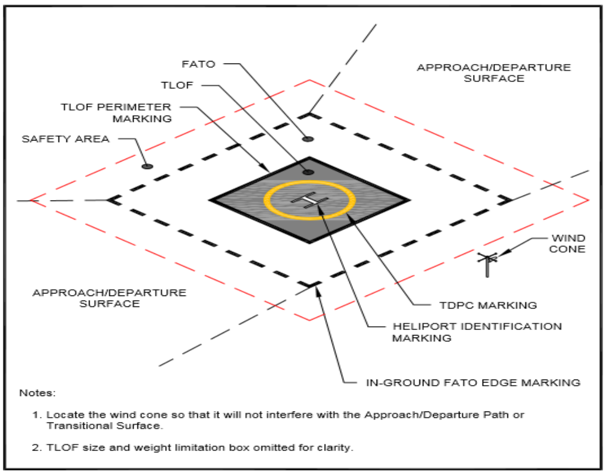
Jenis komponen struktur	Lendutan yang diperhitungkan	Batas lendutan
Atap datar yang tidak menumpu atau tidak disatukan dengan komponen nonstruktural yang mungkin akan rusak oleh lendutan yang besar	Lendutan seketika akibat beban hidup *L*	**ℓ/180***
Lantai yang tidak menumpu atau tidak disatukan dengan komponen nonstruktural yang mungkin akan rusak oleh lendutan yang besar	Lendutan seketika akibat beban hidup *L*	**ℓ/360**
Jenis komponen struktur	**Lendutan yang diperhitungkan**	**Batas lendutan**
Konstruksi atap atau lantai yang menumpu atau disatukan dengan komponen nonstruktural yang mungkin akan rusak oleh lendutan yang besar	Bagian dari lendutan total yang terjadi setelah pemasangan komponen nonstruktural (jumlah dari lendutan jangka panjang, akibat semua beban tetap yang bekerja, dan lendutan seketika, akibat penambahan beban hidup)†	**ℓ/480‡**
Konstruksi atap atau lantai yang menumpu atau disatukan dengan komponen nonstruktural yang mungkin tidak akan rusak oleh lendutan yang besar.		**ℓ/240§**

*Batasan ini tidak dimaksudkan untuk mencegah kemungkinan penggenangan air. Kemungkinan penggenangan air harus diperiksa dengan melakukan perhitungan lendutan, termasuk lendutan tambahan akibat adanya penggenangan air tersebut, dan mempertimbangkan pengaruh jangka panjang dari beban yang selalu bekerja, lawan lendut (*camber*), toleransi konstruksi, dan keandalan sistem drainase.
†Lendutan jangka panjang harus dihitung berdasarkan ketentuan 9.5.2.5 atau 9.5.4.3, tetapi boleh dikurangi dengan nilai lendutan yang terjadi sebelum penambahan komponen non-struktur. Besarnya nilai lendutan ini harus ditentukan berdasarkan data teknis yang dapat diterima berkenaan dengan karakteristik hubungan waktu dan lendutan dari komponen struktur yang serupa dengan komponen struktur yang ditinjau.
‡Batas lendutan boleh dilampaui bila langkah pencegahan kerusakan terhadap komponen yang ditumpu atau yang disatukan telah dilakukan.
§Batas lendutan tidak boleh lebih besar dari toleransi yang disediakan untuk komponen non-struktur. Batasan ini boleh dilampaui bila ada lawan lendut yang disediakan sedemikian hingga lendutan total dikurangi lawan lendut tidak melebihi batas lendutan yang ada.

2.8 SURFACE LEVEL HELIPORT DESAIN

In (FAA: AC 150/5390-2C, 2004) Federal Aviation Adminitration (2009) 150/5230-2c on Heliport Design explanation assumes that there will not be more than one helicopter in the final approach and takeoff area (FATO) and associated safety areas. If more than one touchdown and takeoff (TLOF) is required at a Surface Leevel heliport. The basic Surface Leevel Heliport consists of the TLOFs contained in the FATO. Table 2.6 shows how the standards for safety area width vary as a function of heliport markings. The FATO contains only one TLOF.

Figure 2.1 Surface Level Heliport Desain



2.9 COST BUDGET PLAN

Before the project starts, the preparation of RAB (Budget Plan) is very important as a guideline for implementation. COST BUDGET PLAN includes the selection of service providers, raw materials, and tender supervision according to the contract. The preparation of the RAB refers to the Minister of Transportation Regulation and West Manggarai HSPK to determine the cost of making the Heliport.

3. RESEARCH METHOD

In this study to determine the thickness of rigid pavement using the FAA manual method and using the FAARFIELD software method. To ensure a more accurate rigid pavement thickness, calculations using the FAARFIELD application are used. then the PCN and ACN calculations are carried out using comfaa software. design the heliport surface level markings according to the rules that have been determined and calculate the cost budget plan for making the heliport surface level. in this method requires data in the form of annual departure, soil CBR, the largest aircraft plan

4. RESEARCH RESULT

The calculation of helipad thickness at Komodo Airport Labuan Bajo uses the FAA manual method, referring to the largest helicopter. The data used includes the soil CBR value, the maximum load of the operating helicopter, and the annual take-off frequency. Using FAARFIELD software, the pavement layer thickness can be obtained and displayed on a graph. The output shows the thickness of the layers consisting of surface, top foundation, and bottom foundation. The CBR data used was obtained from the 2019 test conducted during On the Job Training.

Table 4.1 CBR

Number	CBR (%)	%
1	7,631	6,82
2	5,679	
3	7,544	
4	5,679	
5	7,544	

Each helicopter has a different landing gear configuration, affecting the pavement conditions at the aerodrome. The load of the helicopter is distributed to each wheel, so the more wheels, the lighter the load on the pavement. The main landing gear bears 95% of the load, while the nose gear only 5%. The pavement design must be able to withstand the distributed load from all the helicopter wheels. MTOW (Maximum Take Off Weight) calculations were performed for helicopters operating at Komodo Airport Labuan Bajo based on the type of landing gear used.

Table 4.2 Super Puma Characteristics

Helicopter Plan	SA / AS-332, SUPER PUMA
Length	18,7 m
Height	4,97 m
Gross Weight	11.000 kg
Maximum Weight	11.200 kg
Main Rotor Diameter	16,2 m
Main Rotor Area	206,15 m

To calculate the thickness of helipad pavement using 2 methods, namely the manuak graph method and the FAARFIELD application method because the data used in addition to soil CBR values and helicopter loads also calculate the number of annual helicopter departures operating at the airport so that the calculation of pavement thickness is more accurate and efficient.

Among the different wheel configurations that helicopters have, each wheel type has a different loading that impacts the pavement condition. The more the load is shared to each landing gear, the greater the load passing through the pavement. If the number of helicopter wheels is greater, the load shared will be greater, and vice versa if the number of helicopter wheels is less.

4.1 Wheel Load Calculation

The main landing gear is the wheel that receives 95% of the load from the helicopter itself where the landing gear on the helicopter is the main focus, while the nose gear only receives 5% of the helicopter load.

After knowing the MTOW (Maximum Take Off Weight) load of the helicopter operating at Komodo Labuan Bajo Airport, the wheel load calculation can be done on each type of helicopter operating. Calculation of helicopter wheel load as follows

Wheel load =

$$0,95 \text{ x MTOW x } \frac{1}{Number\ of\ Main\ Landing\ Gear}$$

- Bell-429: *Wheel load* = 0,95 x 7.000 x ½ = 3.500 lbs
- SA/AS-332: *Wheel load* = 0,95 x 20.173 x ¼ = 4.790lbs

4.2 Determining the Most Critical Helicopters Operating

In determining the thickness of the pavement, the largest helicopter has also been determined which is the reference in calculating the thickness of this pavement, where the helicopter used in the calculation is the Super Puma SA / AS-332 helicopter aircraft of 20,173 pounds. With a dual wheel wheel configuration, so that later in the construction design the thickness of the pavement can withstand these loads. The plan for pavement construction design uses K-350 concrete quality. As well as, tensile strength (flexural strenght) which is supported by using wiremesh.

4.3 Manual Calculation of Pavement Thickness of Surface Level Heliport

1. *Subgrade*

   In planning rigid pavement, the modulus value of the foundation is required. This foundation modulus value is determined as the subgrade reaction modulus (k), where the results will be plotted onto the subbase thickness graph contained in AC 150/5320-6D (FAA method).

   The formula for converting CBR values into subgrade reaction modulus values is as follows:

   $$K = \left(\frac{1500\ x\ CBR}{26}\right)^{0,7788}$$

   k = modulus of subgrade reaction

   From the data obtained, the CBR of the field soil is obtained according to the appendix. Then we obtain the value of k, namely

   $$k = \left(\frac{1500\ x\ CBR}{26}\right)^{0,7788}$$

   $$k = \left(\frac{1500\ x\ 6,82}{26}\right)^{0,7788}$$

   k = 104,932 pci ≈ 105 pci

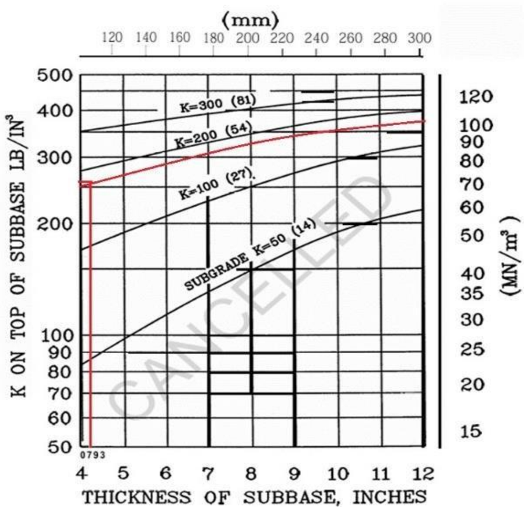
2. *subbase*

   Then after determining the value of subgrade reaction modulus (k), which is k = 113 pci, the subbase thickness can be adjusted by plotting it on the subbase thickness graph. With the condition that the subbase CBR value ≥ 25%, the subbase CBR of 25% is used. The K value of the subbase is:

   $$k = \left(\frac{1500\ x\ CBR}{26}\right)^{0,7788}$$

   The projected value of k subgrade = 113 pci and k subbase = 288.5 = 289 pci Obtained, the minimum subbase thickness is inch or cm. to get more security in planning the thickness of the subbase, 11 cm is chosen.

Figure 4.1 Subbase Thickness Calculation Chart



3. Slab Beton

   In calculating the planning thickness of concrete slabs / concrete slabs on rigid pavements, it is necessary to project the value to the concrete slab calculation chart. To determine the Flexural Strength used Eq.

   MR=K x √fc'

   K = constant (value 8,9,10)

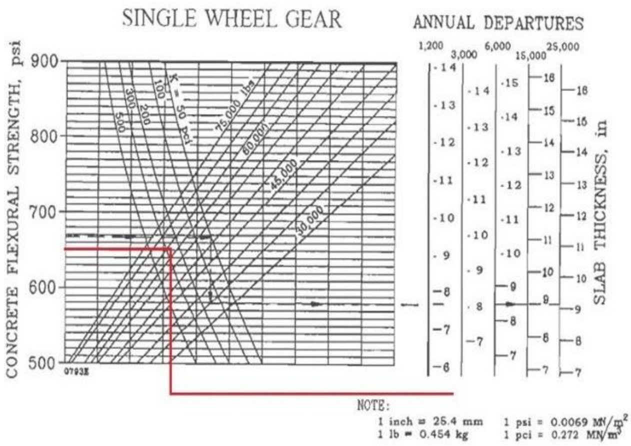
   fc' = Concrete compressive strength (Psi)

   planning the type of concrete used is concrete with type K 350 = 350 Kg / cm2 = 4,977 Psi and the value of k = 9, so as to get a flexural strength value of:

   MR = 9 √4977 = 634.94 Psi = 650 Psi

   After obtaining the MR (Modulus of Rupture or modulus of collapse or deflection strength) value of 650 Psi, then plot on the graph for each helicopter the value of flexural strength, the price of k, MTOW, and annual departure.

Figure 4.2 Concrete Slab Thickness Calculation Chart

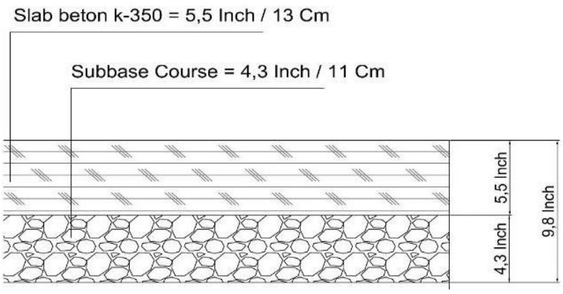


In the process of planning the concrete slab thickness, a flexural strength of 650 psi was used, which was chosen to correspond to a concrete grade of K-350. Then, a line was drawn horizontal from this value to the K value of the subbase, which is 289 pci. Next, the line was drawn down to the MTOW value of the Super Puma aircraft, which is 20,172 lbs. After that, the line is drawn horizontal to the pavement thickness value corresponding to the Annual Departure of 30. With this method, the minimum concrete slab thickness required is about 5.5 inches or about 13 cm

Furthermore, calculating the planned thickness of the Surface Level Heliport pavement with a soil bearing capacity (CBR) of 6.82% using the method above, the thickness is obtained as follows:

- CBR value 6.82% with K Subgrade value 105 pci
- Thickness of subbase = 4.3 Inch (K subbase 289 pci)
- Thickness of concrete slab = 5.5 Inch (fs = 650 psi)

Figure 4.3 Pavement Thickness



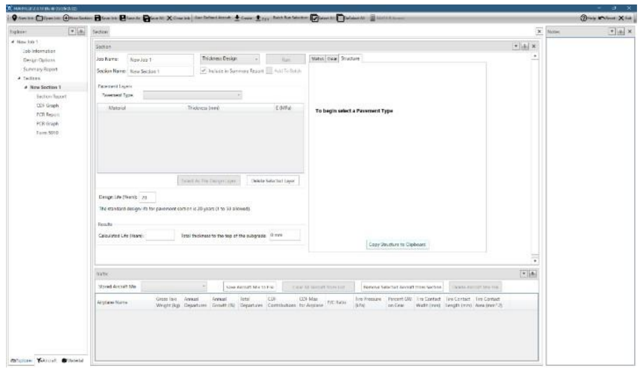
4.4 Calculation of Pavement Thickness of Surface Level Heliport Using FAARFIELD

The pavement design process using the FAARFIELD programme involves effective interaction for pavement design, particularly rigid pavements. In general, the steps of using the FAARFIELD programme include several important stages as follows:

1. On the starup menu, select 'Crate a new job'.
2. After that, copy the 'Sectio Name' according to the plan into the job that has been created. Then go to the 'Structure' tap
3. Modify the layer thickness and type of pavement structure to be analysed.
4. From the 'airplane' tab, select the type of helicopter and the load.
5. Select 'Life / Compaction', to determine the residual life and compaction requirements.
6. Select 'Design Structure' for the pavement thickness requirement 6.
7. Return to Startup and view the analysis report.

In planning the design thickness of the paved shoulder pavement on the runway there are several layers and each layer is designed with a certain thickness in order to withstand the load of the aircraft on it.
Below is the initial appearance of the FAARFIELD 2.0.7 software:

Figure 4.4 FAARFIELD App View



The steps in using FAARFIELD software are as follows:

1. Create a New Job

   In the initial display, select 'New Job' and type the type of work to be carried out, for example in this study the author gave the name of the project as 'TA'.

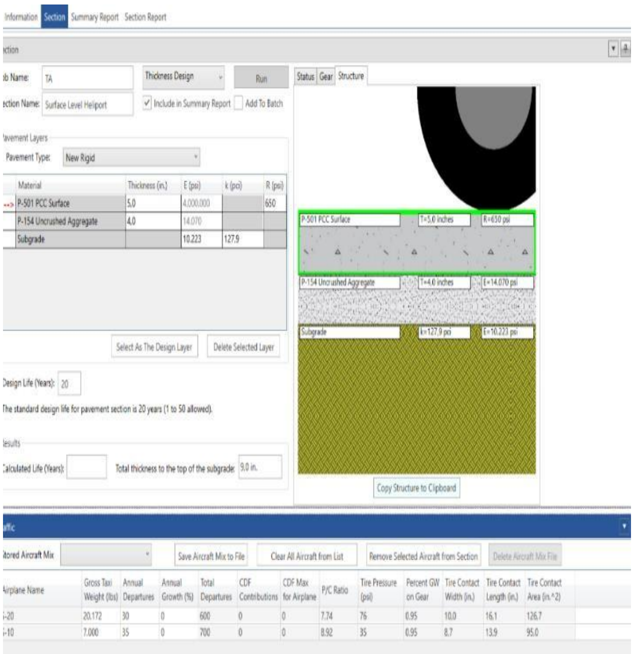
2. Determine the structure to be used

   Then go to the 'Strucute' menu, then, adjust and select the type of structure that will be used for rigid pavement. The following is a table of materials that can be used in planning

The subbase layer was selected, with item P-154 and did not use stabilised base because the plan helicopter weight was <12,500 kg and item type P-501 (Portland Cement Concrete) or PCC as the surface of the rigid pavement layer.

For subgrade soil strength, based on existing data, Komodo Labuan Bajo Airport has a CBR value of 6.82%, then the k value can be calculated in the following way:

Figure 4.5 Material modification results and data used



3. Data Annual Departure

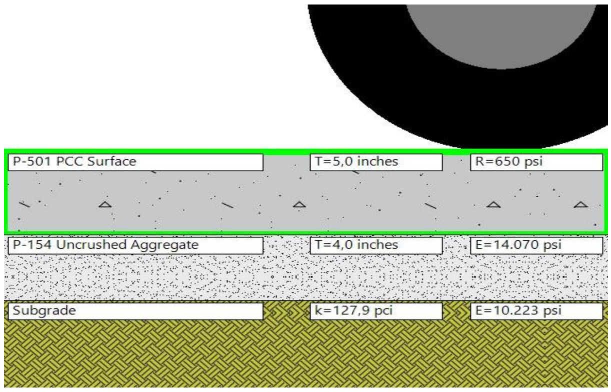
Select the ‘Airplane’ tab to enter data on helicopters in operation and their MTOW, and enter the number of Annual Departures for each helicopter type.

Figure 4.6 Annual Departure

4. Pavement Thickness Results

After all data is entered, namely aircraft data, Annual Departure, the type of pavement to be used, and the strength of the existing subgrade. And then run the programme, the results of the pavement thickness can be seen in Figure 4.7 below:

Figure 4.7 Material modification results and data used



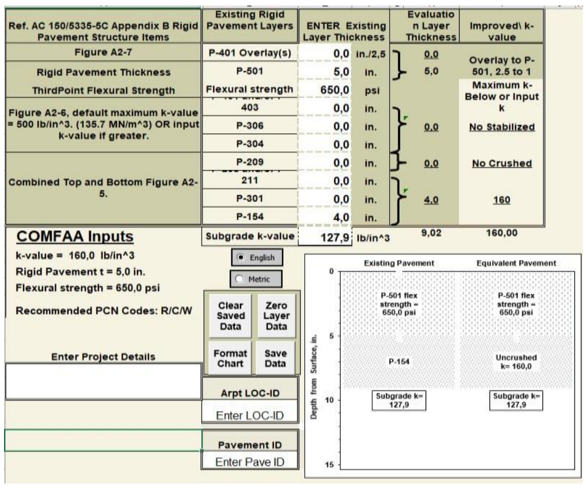
4.5 Calculation of PCN Value using COMFAA

1. FAARFIELD Calculation with COMFAA

After the pavement thickness is determined, the PCN (Pavement Classification Number) value of the pavement layer can be calculated using the FAA manual method with the COMFAA application. The following is the pavement structure thickness data that has been obtained and inputted into the COMFAA software. With the following thickness:

- Subgrade K value: 127 pci
- Subbase thickness: 4 Inch
- Concrete slab thickness: 5 Inch

Figure 4.8 Comfaa app view



The following are the stages of calculating PCN (Pavement Clasification Number)

using COMFAA software

1. Enter the data of aircraft operating at Komodo Labuan Bajo Airport in 2023, then fill in the Annual Departure value.
2. Enter the Subgrade ‘K’ value, then ecaluation thickness, then flexural strength
3. Then click ‘PCN Rigid Batch’

4. Then the programme is run, the value of PCN calculation results is obtained by clicking 'Detai' on the Miscellaneus Fuction menu.
5. Then the results of this calculation will come out, where the PCN, CDF, and ACN values will appear.

From the above results it can be seen that PCN has exceeded ACN, where the ACN of Super Puma is 5.12, while PCN is 8.1, it can be concluded that the PCN value meets, because PCN> ACN. As well as the CDF value of 0.0981.

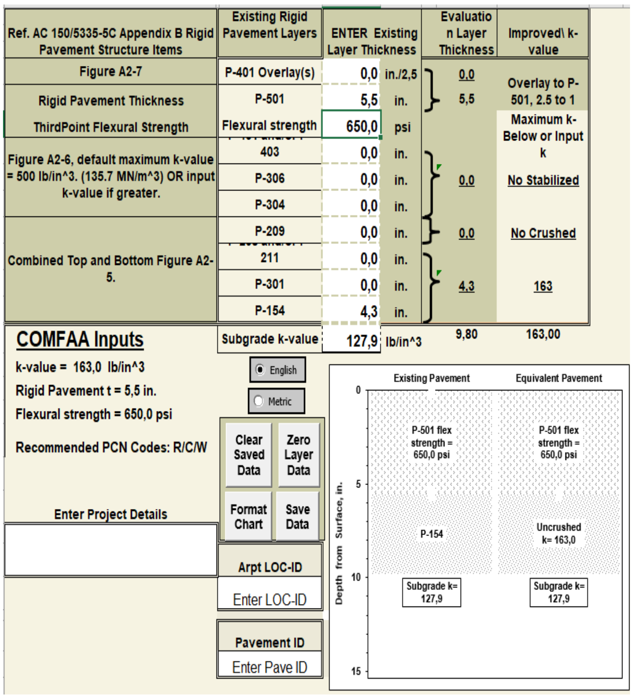
2. Manual Calculation with COMFAA

After the pavement thickness is determined, the PCN (Pavement Classification Number) value of the pavement structure can be calculated using the FAA method with COMFAA software. The following is the pavement structure thickness data that has been obtained and inputted into the COMFAA software. The pavement thickness used is as follows:

- Subgrade K value: 105 pci
- Subbase Thickness: 4.3 Inch
- Thickness of Concrete Slab: 5.5 Inch

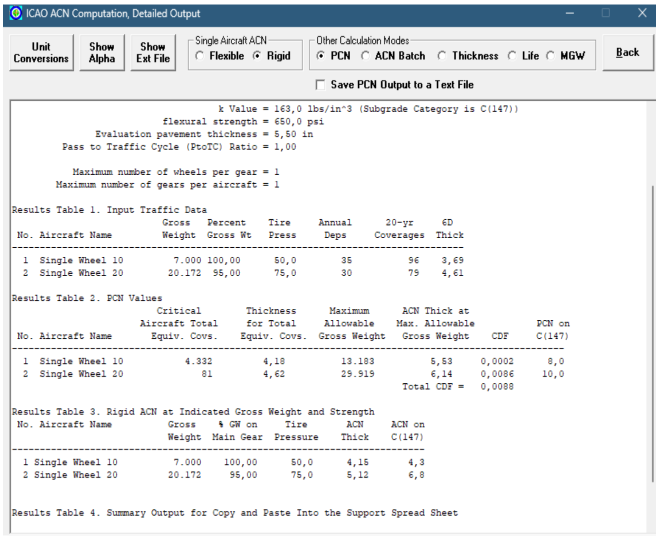
Do the same steps, namely inputting the above data on the spreadsheet in the default FAARFIELD programme, as shown below:

Figure 4.9 Comfaa app view



After obtaining the K-value, do the same steps by entering the data into COMFAA and obtain the PCN calculation results after running the application as follows:

Figure 4.10 Calculation of Nimai PCN with COMFAA Software Application


```
ICAO ACN Computation, Detailed Output
Unit Conversions | Show Alpha | Show Ext File | Single Aircraft ACN: Flexible (•) Rigid | Other Calculation Modes: (•) PCN  ACN Batch  Thickness  Life  MGW | Back
[ ] Save PCN Output to a Text File

                         k Value = 163,0 lbs/in^3 (Subgrade Category is C(147))
                 flexural strength = 650,0 psi
         Evaluation pavement thickness = 5,50 in
     Pass to Traffic Cycle (PtoTC) Ratio = 1,00

      Maximum number of wheels per gear = 1
     Maximum number of gears per aircraft = 1

Results Table 1. Input Traffic Data
                          Gross   Percent    Tire     Annual      20-yr     6D
 No. Aircraft Name        Weight  Gross Wt   Press     Deps     Coverages  Thick
---------------------------------------------------------------------------------
  1  Single Wheel 10       7.000 100,00      50,0       35          96     3,69
  2  Single Wheel 20      20.172  95,00      75,0       30          79     4,61

Results Table 2. PCN Values
                         Critical        Thickness      Maximum      ACN Thick at
                      Aircraft Total     for Total     Allowable    Max. Allowable           PCN on
 No. Aircraft Name      Equiv. Covs.    Equiv. Covs.  Gross Weight   Gross Weight    CDF     C(147)
------------------------------------------------------------------------------------------------------
  1  Single Wheel 10         4.332          4,18         13.183           5,53     0,0002      8,0
  2  Single Wheel 20            81          4,62         29.919           6,14     0,0086     10,0
                                                                    Total CDF =    0,0088

Results Table 3. Rigid ACN at Indicated Gross Weight and Strength
 No. Aircraft Name          Gross   % GW on     Tire       ACN    ACN on
                            Weight  Main Gear  Pressure   Thick   C(147)
------------------------------------------------------------------------
  1 Single Wheel 10         7.000    100,00      50,0      4,15     4,3
  2 Single Wheel 20        20.172     95,00      75,0      5,12     6,8


Results Table 4. Summary Output for Copy and Paste Into the Support Spread Sheet
```

Based on the above results, it can be seen that the PCN value has exceeded the ACN value. The ACN value for Super Puma is 6.14 while the PCN value is 10. Therefore, it can be concluded that the PCN value meets the requirements because PCN > ACN. In addition, the CDF value is 0.0088.

3. Calculation Results of Pavement Structure

A comparison of the results of the rigid pavement structure from the FAA, FAARFIELD, and COMFAA manual methods can be seen in the following table:

Table 4.3 Comparison Table of Pavement

Manual *FAA* dan *COMFAA*	***FAARFIELD* dan *COMFAA***
• Thickness of concrete slab: 5.5 Inch • Subbase Thickness: 4.3 inch • Total Thickness: 9.8 Inch • Maximum Allowable Gross Weight: 36,394 lbs	• Thickness of Concrete Slab: 5 Inch • Subbase Thickness: 4 Inch • Total Thickness: 9 Inch • Maximum Allowable Gross Weight: 24,056 lbs

The results obtained from each method have differences in each layer. This is due to several reasons:

a. In the FAARFIELD software, all aircraft loads are counted as contributors to pavement damage, as indicated by the CDF values. This is different from the manual method, where helicopters are converted to helicopter plans.
b. The pavement thickness values at the surface are different because the graphical method relies on a helicopter design with a dual wheel gear type. Therefore, the critical thickness listed on the graph is used.

c. Manual calculation has a weakness in terms of accuracy in drawing the value line of each parameter to be plotted on the graph, the result obtained can be larger or smaller.

4.6 Marking Planning

Based on the decision of the Directorate General of Civil Aviation contained in KP 215 of 2015 concerning Technical and Operational Standards of Civil Aviation Safety Regulations Part 139 (Manual Of Standard Casr Part 139) Volume II as a guideline in planning Surface Level Heliport.

4.7 Calculation of Cost Budget Plan

After obtaining the results of the structure and design of the helipad, proceed with the preparation of a cost budget plan, according to the volume and area known in the discussion. The results of the preparation of the RAB can be seen in the table below

5. SUGGESTIONS AND CONCLUSIONS

5.1 Conclusion

Based on the results of the analysis in writing this final project, the conclusions obtained are:

1. Calculation of Surface Level Heliport pavement thickness planning using FAA manual method and FAARFIELD software. And the thickness of the pavement calculated through FAARFIELD software will be used for Surface Level Heliport.
2. Based on the RAB calculation, the budget required for painting the markings is IDR 135,283,118.00 and for the total Surface Level Heliport work with an area of 1024 m^2 is IDR 1,475,170,512.00 (one billion four hundred seventy-five million one hundred seventy thousand five hundred twelve rupiah).

5.2 Suggestions

Based on the conclusions, the following suggestions can be made:

1. Future research for helipad needs is expected to take new soil CBR data if this research still uses previous data. In addition, the strength of the planned pavement must be higher than the existing conditions because the pavement will accommodate a larger helicopter.
2. Surface Level Heliport planning construction uses HSPK in 2022 and the price of construction materials always fluctuates every year, so this needs to be considered by PPK and the contractor in planning the cost budget for pavement construction at this Surface Level Heliport.
3. This implementation should be carried out as soon as possible because over time the unit price of each job will experience inflation and if it is not implemented quickly it requires a high cost than planned.

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