# PLANNING OF RIGID PAVEMENT ON SURFACE LEVEL HELIPORT AT KOLONEL ROBERT ATTY BESSING AIRPORT MALINAU - NORTH KALIMANTAN

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**ABSTRACT**

*Rising air mobility in border areas necessitates building a Surface Level Heliport. This study aims to design the rigid pavement structure for the Surface Level Heliport at Kolonel Robert Atty Bessing Airport, Malinau – North Kalimantan, in order to ensure the safety and comfort of helicopter operations. The method used refers to the technical guidelines from the FAA (Federal Aviation Administration), utilizing FAARFIELD software, and PCN calculations using COMFAA software. Using data on annual departures, soil CBR values, and helicopter dimensions, the design calculations include determining the concrete slab thickness, marking layout plan, and reinforcement requirements. The planning results show that the Surface Level Heliport has dimensions of 44 m x 44 m with a required pavement thickness of 4,06 M, using K-350 grade concrete and M6-200 type wire mesh reinforcement. Based on these specifications, the calculated PCN value is 14.5 and the ACN value is 11.1, which can support helicopter loads up to 37,680 lbs. The estimated project cost, based on Minister of Transportation Regulation No. PM 78 of 2014 and the Standard Price List for Goods and Services of Malinau Regency for the 2025 Fiscal Year, is IDR 1.985.066.000,00.*

***Keywords:*** *Rigid, heliport, budget plan, FAARFIELD, COMFAA*

## 1. INTRODUCTION

Kolonel Robert Atty Bessing Airport is a Class III UPBU (Airport Operating Unit) under the Ministry of Transportation, located in Malinau Regency, North Kalimantan Province. Currently, Kolonel Robert Atty Bessing Airport has airside facilities with a runway measuring 1,450 meters in length and 30 meters in width, using flexible pavement structure with a PCN value of 30 F/C/Y/T. The UPBU also has three taxiways, namely Taxiway Alpha, Bravo, and Charlie, as well as an apron measuring 190 m x 70 m. Several airlines operating at this airport include Susi Air, Smart Aviation, Maf Aviation, and Wings Air, with the farthest route from Malinau to Balikpapan.

In order to provide facilities at Kolonel Robert Atty Bessing Airport, several aspects must be considered, one of which is the availability of adequate airside and landside facilities in terms of both quality and quantity. This must comply with the technical requirements and provisions set by the Directorate General of Civil Aviation, which refers to international regulations.

Kolonel Robert Atty Bessing Airport also serves as the final access point for ground travel to remote areas in North Kalimantan, where the Indonesian military uses helicopters as vehicles for troop and logistics distribution to these remote regions. In addition, various other operational activities also cause helicopters to frequently take off and land in the apron area and Taxiway Alpha. As a result, the surface layer of the apron pavement has suffered severe damage. Apart from the apron surface damage, Kolonel Robert Atty Bessing Airport also lacks sufficient helicopter parking facilities.

Therefore, at certain times, MI17V5 type helicopters are forced to land on Taxiway A, which may endanger flight safety.

***Figure 1.*** *Apron Damage*

According to the Regulation of the Minister of Transportation of the Republic of Indonesia Number PM 92 of 2016, it is stated that: *"To support flight operational safety and airport services, every airport facility in operation must meet the required standards, technical provisions, and feasibility."* To ensure flight safety and avoid potential risks, Kolonel Robert Atty Bessing Airport must provide a Surface Level Heliport facility.

The pavement design to be used must be capable of supporting and withstanding the loads of helicopters operating on it. Therefore, with low maintenance costs and the ability of cement or concrete materials to adapt to weight and distribute loads evenly, this system is considered more effective and durable. Based on these considerations, the author chose to use rigid pavement in the design of the Surface Level Heliport.

According to the Regulation of the Director General of Civil Aviation Number 215 of 2019 on Technical Standards and Operational Civil Aviation Safety Regulations, Part 139 (Manual of Standard CASR Part 139), Volume II — Helicopter Landing and Take-Off Areas (Heliport), a heliport is a place for helicopter take-off and landing located on top of a building (Elevated Heliport), on land (Surface Level Heliport), on offshore platforms/ships, or shipboard (helideck). Each heliport construction and operation must comply with the safety standards set by the Directorate General of Civil Aviation in order to ensure aviation safety and security.

***Table 1.*** *Annual Departure Table*

| MONTH | ANNUAL DEPARTURE | TYPE HELIKOPTER |
|---|---|---|
| January | 4 | Bell 412 |
| February | 8 | Bell 412 |
| March | 24 | Bell 412, EC725 |
| April | 1 | Bell 412 |
| May | 3 | Bell 412 |
| June | 0 | - |
| July | 4 | Bell 412 |
| August | 13 | Bell 412 |
| September | 41 | Bell 412,MI17V5 |
| October | 15 | Bell 412 |
| November | 4 | Bell 412 |
| December | 2 | Bell 412 |
| TOTAL | 119 | |

This study aims to determine the required rigid pavement thickness for the designed heliport structure, with the strength to withstand the load of the most critical helicopter, namely the MI17V5. The calculation is based on the FAA (Federal Aviation Administration) method in accordance with Advisory Circular No. 150/5320-6G *"Airport Pavement Design and Evaluation"* as well as the FAARFIELD application, which refers to Advisory Circular No. 150/5320-6G *"Airport Pavement Design and Evaluation."*

The problem formulation of the problem is as follows:

1. What is the rigid pavement thickness of the Surface Level Heliport that is capable of supporting the heaviest helicopter load, the MI17V5, at Kolonel Robert Atty Bessing Airport?
2. What is the rigid pavement thickness of the Surface Level Heliport that is capable of supporting the heaviest helicopter load, the MI17V5, at Kolonel Robert Atty Bessing Airport?

## 2. THEORETICAL BASIS

### *2.1 Heliport*

According to ICAO Annex 14, a heliport is an area on land or a specific structure used exclusively or jointly for helicopter landing and take-off, including supporting facilities such as parking, refueling, and maintenance. Meanwhile, under Regulation of the Director General of Civil Aviation No. 215/2019 (Manual of Standard CASR Part 139 Volume II), a heliport is defined as a site for helicopter landing and take-off.

### *2.2 The Specification of Helicopter*

According to the Federal Aviation Administration (FAA) Advisory Circular 150/5390-2D on Heliport Design, the planning of a Surface Level Heliport at an airport requires complete specifications of the helicopters to be operated in order to determine the appropriate infrastructure design. Key specifications include:

1. Weight – The helicopter's weight is crucial in determining pavement thickness and surface strength. The heliport must be able to withstand impact loads during landing at maximum weight as well as static loads from aircraft that remain overnight (RON).
2. Size – The overall length and width of the helicopter directly affect the heliport's dimensions.
3. Heliport Dimensions – These specifications determine the area of land required within the airport for heliport construction.

### *2.3 Pavement Type*

Pavement is an infrastructure system consisting of several layers with different load-bearing capacities, generally classified into two types: flexible pavement and rigid pavement. Flexible pavement is elastic, meaning it deforms under load, and its structural capacity relies heavily on the strength of the subgrade since the load is primarily transferred through the supporting soil. In contrast, rigid pavement uses concrete with cement as the binder, where the primary strength is provided by the rigid concrete slab, allowing the load to be distributed over a wider area and reducing stress on the foundation beneath. According to Advisory Circular (AC) No. 150/5320-6G on Airport Pavement Design and Evaluation, rigid pavement is defined as a type of pavement where most of the load is carried by the concrete slab, with its strength determined by the quality of the concrete, while durability depends on the properties, bearing capacity, and uniformity of the subgrade. In rigid pavement design, the subbase plays an essential role in reducing the effects of soil expansion and contraction, preventing pumping at joints, providing stable and uniform support, and serving as a working platform during construction. The concrete slab is a structural element with relatively small thickness compared to its length and width, made of a mixture of Portland cement, fine aggregate, coarse aggregate, water, and additives to form a solid mass. The slab thickness is designed based on flexural strength, calculated using the formula $MR = K \times fc'$, where MR is the modulus of rupture, K is a constant (8, 9, or 10), and fc' is the compressive strength of concrete. Beneath the slab is the subbase course, which provides uniform support, assists drainage, controls expansive soil movements, maintains stability, and prevents the upward migration of fine particles, with a typical minimum thickness of 0.10 m. According to AC 150/5320-6G, acceptable subbase materials include P-154 Subbase Course, P-208 Aggregate Base Course, P-209 Crushed Aggregate Base Course, P-211 Lime Rock Base Course, P-301 Soil Cement Base Course, P-304 Cement Treated Base Course, P-306 Ecoconcrete Base Course, P-401 Plant Mix Bituminous Pavement, and P-403 HMA Base Course, with a recommended minimum thickness of 4 inches (102 mm) for stabilized materials. The lowest layer, the subgrade, is the natural soil compacted as the foundation of the pavement system, where the stress must be maintained below its bearing capacity to prevent deformation. In Indonesia, subgrade strength is determined using the California Bearing Ratio

(CBR) test, which is then converted into a resilient modulus (MR) using the formula K = (1500 × CBR / 26)^0.7788.

## *2.4 Manual FAA Method*

The determination of pavement thickness can be carried out through manual analysis by applying charts for each layer based on FAA-AC No: 150/5320-6D. The calculation process begins with preparing the supporting data for the first step, such as subgrade soil strength (CBR Subgrade), the calculation of Equivalent Annual Departures, and the determination of flexural strength. This data is then projected onto the charts to determine the required thickness of the subbase and concrete slab, as illustrated in the figure below.

## 2.5 *FAARFIELD Method*

FAARFIELD is an application developed by the FAA to calculate both flexible and rigid pavements in aircraft movement areas, such as aprons and taxiways. The calculations in FAARFIELD are based on the methodology of FAA-AC No: 150/5320-6G. The application is designed using the Cumulative Damage Factor (CDF) concept, allowing for more efficient and faster computations. By simply inputting numerical data, users can easily obtain results such as the estimated maximum gross weight of aircraft that the pavement can support.

## *2.6 Software COMFAA*

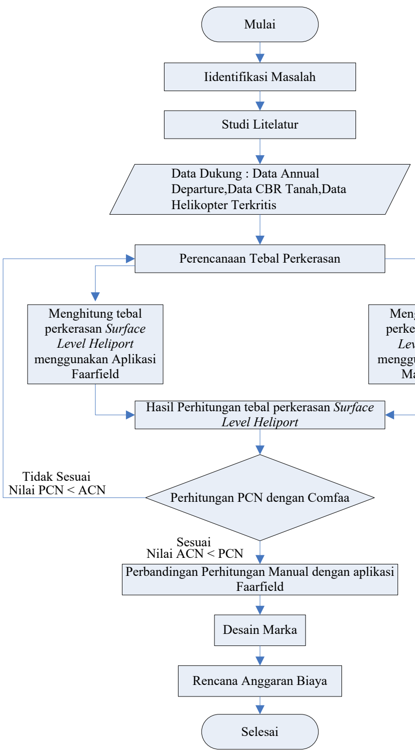
ACN/PCN is the ICAO standard used to determine the pavement strength value for concrete or asphalt at airports, with no alternative methods allowed. This system evaluates the impact of aircraft on pavements using a numerical scale. For helicopters, the evaluation is based on the maximum allowable gross weight. One of the main tools used in this calculation is COMFAA, a computer program designed to determine PCN values and calculate the maximum allowable gross weight. The program provides a systematic calculation process and clear output interpretation. Additionally, COMFAA is supported by a Microsoft Excel spreadsheet to calculate equivalent thickness, which will be explained further in this module. Both COMFAA and the spreadsheet can be accessed free of charge through the official website of the U.S. Federal Aviation Administration (FAA).

## *2.6 Design Marking Heliport*

In the Federal Aviation Administration (FAA) 150/5320-2D on Heliport Design (2009), the standard model estimates that only one helicopter will be present in the final approach and takeoff area (FATO) and its associated safety area at any given time. If a heliport requires two or more touchdown and liftoff areas (TLOF), the design layout must take into account the appropriate safety considerations.

# 3. RESEARCH METHODS

This study applies a quantitative approach, analyzing the problem using established theoretical frameworks in the field. The method falls under descriptive analysis, meaning that the information is gathered and interpreted based on conditions observed during the research period. The steps undertaken in the research process are outlined through a flowchart, as shown below.



This research was conducted at Kolonel Robert Atty Bessing Airport in Malinau, North Kalimantan, which serves as a vital access point to remote areas and is frequently used by the Indonesian military for troop and logistics distribution via helicopters. Currently, the airport lacks a dedicated Surface Level Heliport, forcing helicopters to land on the apron and Taxiway Alpha, posing safety risks and potential pavement damage. To address this issue, the study applies a literature review based on FAA Advisory Circulars, ICAO Annex 14, and Indonesian regulations, combined with direct observation and data collection during On-the-Job Training. The methodology includes manual pavement thickness calculation using FAA standards, supported by FAARFIELD for validation and COMFAA for PCN evaluation. Structural planning focuses on designing a heliport that can safely accommodate the MI-17V5 helicopter. The study also considers pavement stress distribution, critical vs. non-critical areas, and compliance with FAA heliport marking standards. Finally, the cost estimation follows the Ministry of Transportation Regulation PM 78/2014 and the Malinau District Government's unit price guidelines for the 2025 fiscal year.

## 4. RESULTS AND DISCUSSION

### *4.1 The Specification of Helicopter*

The pavement thickness planning for the surface-level heliport at kolonel Robert Atty Bessing Airport is located in front of the Heavy Equipment (AAB) building. This location was selected due to the limited available land within the airport area. As outlined in the previous subtopic, the purpose of this planning is to accommodate helicopter operations, particularly the largest helicopter expected to operate at the airport, ensuring that flight services can be carried out effectively. The heliport pavement design is based on the FAA Advisory Circular No. 150/5320-2D (2021) and takes into consideration the most critical helicopter operating at the airport, namely the MI-17V5.

***Table 2.*** *Helicopter type*

| NO | Helicopter | MI17V5 |
|---|---|---|
| 1. | Overall Length | 25.352 Mm |
| 2. | Fuselage Length | 18.989 Mm |
| 3. | Main Rotor Diameter | 21.294 Mm |
| 4. | Empty Weight | 7.240 Kg |
| 5. | Max Take-off Weight | 13.000 Kg |
| 6. | Height | 5.544 Mm |
| 7. | *Maximum level-flight speed* | 240 km/h |

Rigid pavement was chosen as the pavement type for the surface-level heliport due to its lower maintenance requirements and better adaptability to the weight distribution of concrete and cement. This system provides an effective solution for distributing the heavy loads of helicopters evenly, making it more durable and reliable in supporting the designed operational demands.

### *4.2 Dimension Planning of Surface Level Heliport*

The surface-level heliport is required to accommodate the largest helicopter, the MI17V5, to ensure that the apron remains undamaged and can be utilized efficiently. This allows aircraft operations to run optimally, enabling helicopters to take off and land freely at Kolonel Robert Atty Bessing Airport.

***Table 3.*** *Helicopter Movement Area*

| Tipe | TPDC (*Touchdown /position circle*) | TLOF (*Touchdown and Lift-Off Area*) | FATO (*Final Approach and TakeOff Area*) | Jarak TLOF-FATO | *Safety Area* |
|---|---|---|---|---|---|
| MI17V5 | Diameter dalam minimum | Lebar dan Panjang Minimum | Lebar Panjang Minimum | Jarak minimum | Jarak minimum batas Safety |
| | ½ D | 0,83 D | 1,5 D | 0,34 D | 0, 28 D |
| | ½ x 21.294 | 0,83 x 21.294 | 1,5 x 21.294 | 0,34 x 21.294 | 0,28 x 21.294 |
| | 12,676 | 17,67402 | 38,028 | 8,619 | 7,098 |
| Dimensi | 13 M | 18 M | 38 M | 8,5 M | 7 M |

After determining the helicopter dimensions, the pavement thickness for the Surface Level Heliport is calculated using the FAA chart method and the FAARFIELD software. This approach not only considers the subgrade CBR as a parameter but also takes into account the annual departures (MTOW) operating at the airport, making the pavement thickness calculation more detailed and efficient. Helicopters have several landing gear configurations, and the load distribution for each type of landing gear significantly affects the pavement condition.

### *4.3 Equivalent Annual Depature*

After identifying the critical and largest type of helicopter, the next step is to calculate all annual helicopter departures operating at Kolonel Robert Atty Bessing Airport, which are then converted into the configuration of the critical landing gear. This calculation is carried out as if only one type of helicopter operates at Kolonel Robert Atty Bessing Airport. The Equivalent Annual Departure is then projected onto the pavement equivalent thickness chart. The following presents the calculation of the equivalent annual departures (RI) for helicopters operating at Kolonel Robert Atty Bessing Airport.

$$LogR1 = (LogR2) \times \left(\frac{W2}{W1}\right)^{\frac{1}{2}}$$

***Table 4.** Equivalent Annual Depature*

| Jenis Helikopter | *Gear Type* | | | AD | MTOW | *Annual Departure* konversi | *Wheel Load* | *Wheel Load* Terkritis | *EAD* |
|---|---|---|---|---|---|---|---|---|---|
| | dari | ke | kon | | | R2 | W2 | W1 | R1 |
| Bell 412 | *Skid* | *Single Wheel* | 1 | 109 | 11.900 | 109 | 2826,25 | 6807,93 | 70,23 |
| EC 725 | *Single Wheel* | *Single Wheel* | 1 | 5 | 24.696 | 5 | 5778,85 | 6807,93 | 4,60 |
| MI17V5 | *Single Wheel* | *Single Wheel* | 1 | 5 | 28.665 | 5 | 6807,93 | 6807,93 | 5 |
| TOTAL | | | | 119 | | | | | 80 |
| W2 | : | *Wheel load* dihitung dengan menganggap 95% ditumpu oleh roda pendaratan utama, *dual wheel* mempunyai 2 roda maka = MTOW x 0,95 x 1/4) | | | | | | | |
| W1 | : | *Wheel load* pesawat kritis/terbesar | | | | | | | |

Bell 412= $LogR1(Log109)x\left(\frac{2826,25}{6807,93}\right)^{\frac{1}{2}}$= 70,23

EC725 = $Log\ R1 = (Log\ 5) \times \left(\frac{5778,85}{6807,93}\right)^{\frac{1}{2}}$= 4,60

MI17V5 = $Log\ R1 = (Log\ 5) \times \left(\frac{6807,93}{6807,93}\right)^{\frac{1}{2}}$= 5

After obtaining the R1 value for each helicopter, the next step is to calculate the total, resulting in an Equivalent Annual Departure value of 80 for all helicopters. This value will then be applied to the pavement thickness chart to determine the final pavement thickness.

### *4.4 Manual FAA Pavement Thickness Calculation*

**Subgrade**

The foundation modulus value is required for rigid pavement. This foundation modulus can be represented as the subgrade reaction modulus (k), and the result will be plotted into the subbase thickness chart in AC 150/5320-6D. The formula to convert the CBR value into the subgrade reaction modulus is as follows:

$$K = \left[\frac{1500\ \times\ CBR}{26}\right]^{0,7788}$$

From the data obtained, the field CBR value is 8.8% (according to the appendix). Therefore, the value of *k* is:

$$K = \left[\frac{1500 \times 8,8}{26}\right]^{0,7788} = 127,97 \approx 128$$

**Subbase**

After obtaining the subgrade reaction modulus (k) of 128 pci, the next step is to determine the thickness of the subbase layer by projecting this value into the subbase thickness chart. With the requirement that the CBR value for the subbase must be ≥ 25%, a subbase CBR value of 25% is used. The *k* value for the subbase is:

$$K = \left[\frac{1500 \times 25}{26}\right]^{0,7788} = 288,5 \approx 289$$

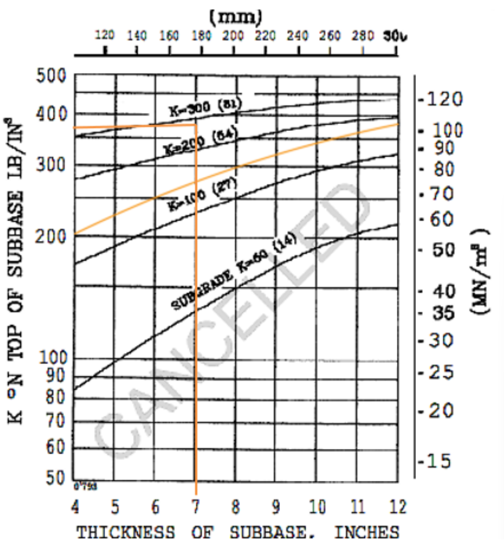



***Figure 2.** Thegraphic projection*

**Surface**

In designing the thickness of the concrete slab in rigid pavement, several parameters must be mapped into the concrete slab thickness calculation chart. To calculate the flexural strength, the following equation is used:

$$\boldsymbol{MR = K\,x\,\sqrt{fc'}}$$

- MR = Flexural Strength
- K = Constant (value 9)
- f'c = Concrete Compressive Strength (Psi)

The concrete quality designed is K-350, equivalent to 350 kg/cm² = 5076 Psi, with K = 9. Thus, the flexural strength is obtained as:

$$MR = 9\,x\,\sqrt{5076} = 650 \text{ Psi}$$

By projecting the MR value of 650 Psi and linking it with the subbase foundation modulus of 289 pci, then applying it to the thickness chart corresponding to the Equivalent Annual Departure of 80, the concrete slab thickness is determined to be 6 inches (15.24 cm).

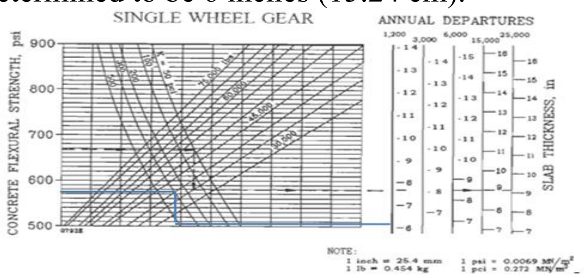



***Figure 3.*** *Thegraphic projection*

The planned thickness values of the rigid pavement structure for the Surface Level Heliport with a CBR of 8.8%, based on the CBR data at Kolonel Robert Atty Bessing Airport, Malinau, are as follows:

- Subgrade value = 156 pci = 42.3 MN/m³
- Subbase thickness = 17.78 cm = 7 in
- Surface thickness = 15.2 cm = 6 in
- Flexural strength = 650 psi = 4.48 MPa

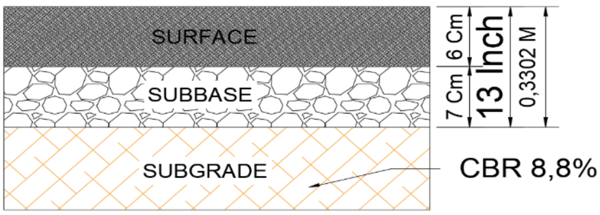
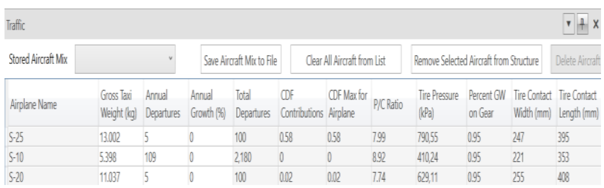



***Figure 4***. *Concrete pavement thickness plan*

*4.5 Pavement Thickness Calculation Using FAARFIELD*

The FAARFIELD program is one of the best tools used for pavement design, particularly for rigid pavement. The procedure for using FAARFIELD can be summarized as follows:

1. Click "New Job" after the startup menu appears.
   Select "New Job" in the FAARFIELD application, then enter the "Job name" and "Section name" as needed. For the pavement type, select "New Rigid" since rigid pavement is used in this design.
2. The planned helicopter has a weight of less than 60,000 lbs**;** therefore, the pavement structure does not require a stabilized base or base layer. Item P-154 is used for the subbase layer, and Item P-501 (Portland Cement Concrete Pavement) is used for the rigid pavement surface layer. The subgrade strength from the data at Kolonel Robert Atty Bessing Airport is 8.8% CBR. The modulus of subgrade reaction (K) can be determined using the formula from AC No.150/5320-6G**:**
   $K = 28.6926 \text{ x } CBR^{0,7788}$
   $K = 28{,}6926\ X\ 8{,}8^{0,7788}$
   $K = 161{,}41 \approx 161$ pci
3. Select the "Airplane" tab at the bottom left. Then enter the operating aircraft data, the annual departure data, along with the MTOW of each helicopter.



Traffic

Stored Aircraft Mix | Save Aircraft Mix to File | Clear All Aircraft from List | Remove Selected Aircraft from Structure | Delete Aircraft

| Airplane Name | Gross Taxi Weight (kg) | Annual Departures | Annual Growth (%) | Total Departures | CDF Contributions | CDF Max for Airplane | P/C Ratio | Tire Pressure (kPa) | Percent GW on Gear | Tire Contact Width (mm) | Tire Contact Length (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| S-25 | 13.002 | 5 | 0 | 100 | 0.58 | 0.58 | 7.99 | 790,55 | 0.95 | 247 | 395 |
| S-10 | 5.398 | 109 | 0 | 2,180 | 0 | 0 | 8.92 | 410,24 | 0.95 | 221 | 353 |
| S-20 | 11.037 | 5 | 0 | 100 | 0.02 | 0.02 | 7.74 | 629,11 | 0.95 | 255 | 408 |

***Figure 5.*** *MOTW*

4. Planned Pavement Thickness Results
   After all the data has been entered, such as Annual Departure data, pavement model, helicopter type, and the strength of the existing subgrade, the pavement thickness begins to be defined using the

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

- Subgrade K-value = 161 pci = 43.7 MN/m³
- Subbase thickness = 15.2 cm = 6 inches
- Surface thickness = 15.2 cm = 6 inches

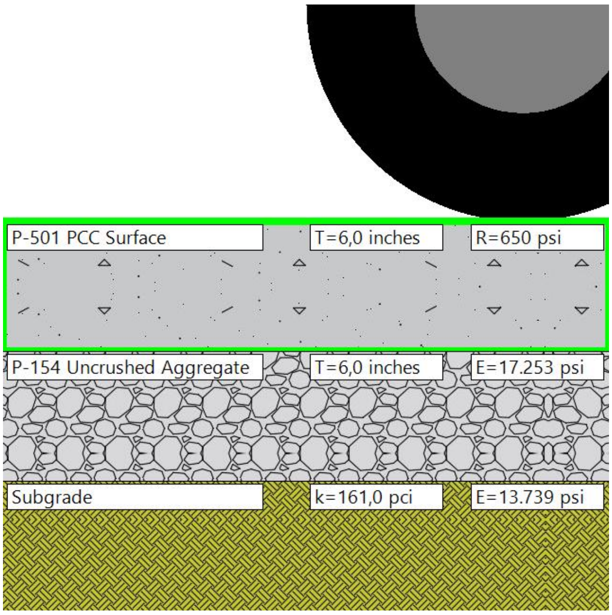



***Figure 6.*** *Concrete Pavement Thickness plan*

*4.5 Maximum Allowable Calculation Using COMFAA Software*

*4.5.1 Manual FAA*

Before entering the data into the COMFAA software, input the data into a spreadsheet. This is done to determine the Evaluation Thickness of the pavement, which will later be entered into the COMFAA software. The steps are as follows:

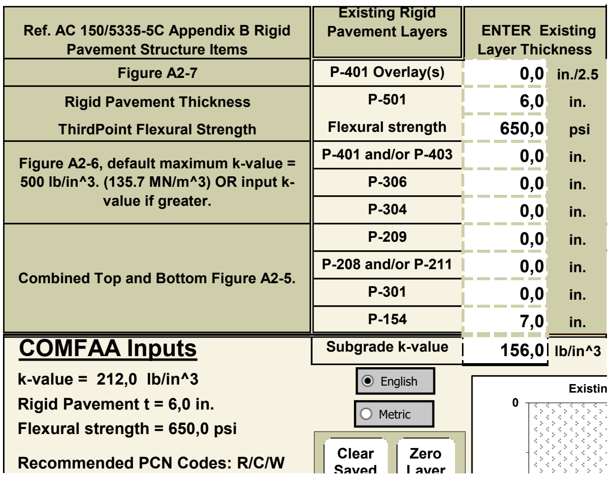
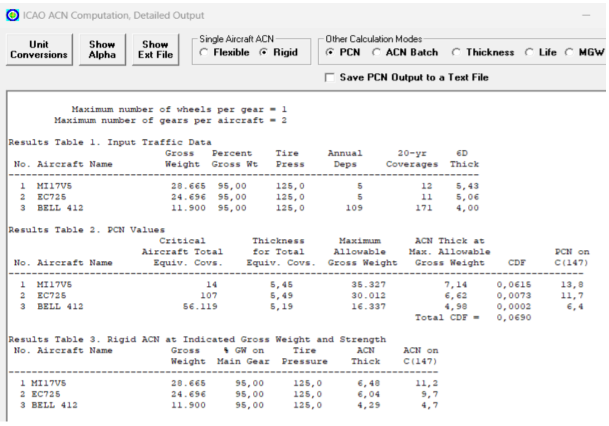



***Figure 7.*** *COMFAA Spreadsheet*

The next step is to input the aircraft data into the COMFAA software and run the analysis. The results are as follows:



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

Save PCN Output to a Text File

Maximum number of wheels per gear = 1
Maximum number of gears per aircraft = 2

Results Table 1. Input Traffic Data

| No. | Aircraft Name | Gross Weight | Percent Gross Wt | Tire Press | Annual Deps | 20-yr Coverages | 6D Thick |
|---|---|---|---|---|---|---|---|
| 1 | MI17V5 | 28.665 | 95,00 | 125,0 | 5 | 12 | 5,43 |
| 2 | EC725 | 24.696 | 95,00 | 125,0 | 5 | 11 | 5,06 |
| 3 | BELL 412 | 11.900 | 95,00 | 125,0 | 109 | 171 | 4,00 |

Results Table 2. PCN Values

| No. | Aircraft Name | Critical Aircraft Total Equiv. Covs. | Thickness for Total Equiv. Covs. | Maximum Allowable Gross Weight | ACN Thick at Max. Allowable Gross Weight | CDF | PCN on C(147) |
|---|---|---|---|---|---|---|---|
| 1 | MI17V5 | 14 | 5,45 | 35.327 | 7,14 | 0,0615 | 13,8 |
| 2 | EC725 | 107 | 5,49 | 30.012 | 6,62 | 0,0073 | 11,7 |
| 3 | BELL 412 | 56.119 | 5,19 | 16.337 | 4,98 | 0,0002 | 6,4 |
| | | | | | Total CDF = | 0,0690 | |

Results Table 3. Rigid ACN at Indicated Gross Weight and Strength

| No. | Aircraft Name | Gross Weight | % GW on Main Gear | Tire Pressure | ACN Thick | ACN on C(147) |
|---|---|---|---|---|---|---|
| 1 | MI17V5 | 28.665 | 95,00 | 125,0 | 6,48 | 11,2 |
| 2 | EC725 | 24.696 | 95,00 | 125,0 | 6,04 | 9,7 |
| 3 | BELL 412 | 11.900 | 95,00 | 125,0 | 4,29 | 4,7 |

***Figure 8.*** *Theresult from COMFAA*

According to Advisory Circular AC 150/5335-5C, the "6D Thickness" value must not exceed the Evaluation Pavement Thickness (soil or concrete layer thickness), and the required CDF (Cumulative Damage Factor) must not exceed 1. As shown by the COMFAA software results, the 6D Thickness value is 5.4 and the total CDF value is 0.0690, indicating that these values meet the requirements. With a PCN value of 13.8, the critical aircraft can be accommodated.

Therefore, it can be concluded that the designed pavement structure is capable of withstanding traffic loads. A thick apron pavement can be designed using a PCC surface with a thickness of 6 inches.

*4.5.2 Software FAARFIELD*

As in the previous step, enter the data into a spreadsheet before using the COMFAA software. The steps are as follows

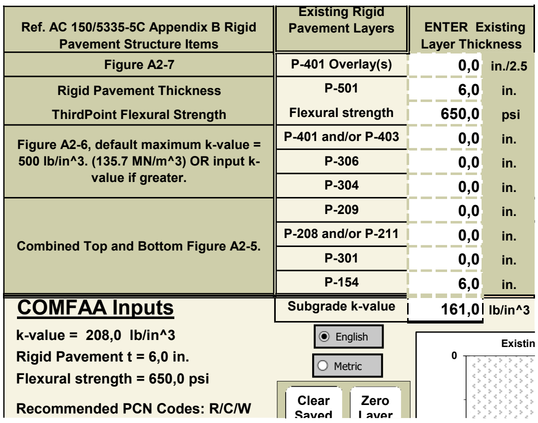



***Figure 9.*** *COMFAA Spreadsheet*

After obtaining the Evaluation Thickness value, the next step is to open the COMFAA software. The following is the main menu display of the COMFAA software. Next, select the planned helicopter type and input it through the "Open Aircraft Window" option, then choose the appropriate helicopter wheel configuration according to the plan. Enter the gross weight, flexural strength, and annual departures data. The next step is to input the CBR value, K-value, and evaluation thickness into the COMFAA software.

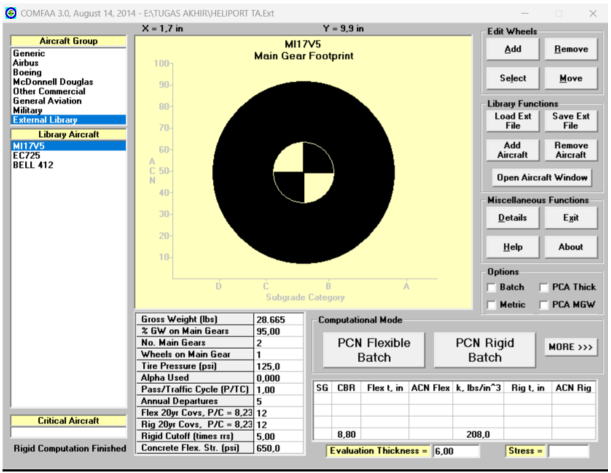



***Figure 10.*** *Menu COMFAA*

Click "PCN Rigid Batch" and wait for COMFAA to process the data. Once the calculation is complete, the results can be viewed by clicking the "Details" button. This menu contains various data, such as PCN, ACN, and Maximum Allowable Gross Weight.

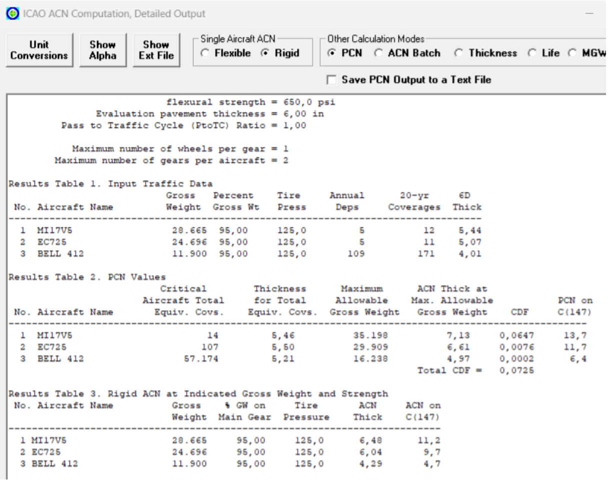



***Figure 11.*** *Theresult from COMFAA*

According to Advisory Circular AC 150/5335-5C, the "6D Thickness" value must not exceed the Evaluation Pavement Thickness (soil or concrete layer thickness), and the required CDF (Cumulative Damage Factor) must not exceed 1. Based on the COMFAA software results, the 6D Thickness value is 5.4 and the total CDF value is 0.0725, indicating that these values meet the requirements. With a PCN value of 13.7, the critical aircraft can be accommodated.

Therefore, it can be concluded that the designed pavement structure is capable of withstanding traffic loads. A thick apron pavement can be designed using a PCC surface with a thickness of 6 inches.

*4.6 Surface Level Heliport Calculation Results*

After completing the pavement thickness calculations, the results of the pavement structure design using the manual FAA method, the FAARFIELD 2.1 application, and the COMFAA software are as follows:

*Table 5. The result*

| OUTPUT | |
|---|---|
| Manual FAA | *Surface* = 0,152 M atau 15,2 Cm<br>*Subbase* = 0,177 M atau 17,7 Cm<br>Thickness= 0,3302 M atau 33,02 Cm |
| FAAR FIELD | *Surface* = 0,152 M atau 15,2 Cm<br>*Subbase* = 0,152 M atau 15,2 Cm<br>Thickness = 0,3048 M atau 30,48 Cm |

- The latest regulation regarding Airport Pavement Design and Evaluation issued by the FAA is Advisory Circular 150/5320-6G, which uses the FAARFIELD program to determine pavement thickness.
- In Advisory Circular 150/5320-6G, only the FAARFIELD method is included. The manual method was in Advisory Circular 150/5320-6D, which has been revoked with the issuance of AC 150/5320-6G.
- The required thickness for pavement design using FAARFIELD is smaller.
- The FAARFIELD method is more accurate in determining pavement thickness.

From these results, it can be concluded that using **FAARFIELD** makes material and cost requirements more efficient while ensuring a quality pavement structure capable of supporting the load of the critical helicopter

*4.7 Surface Level Heliport Marking*

An effective surface-level heliport marking design is crucial for helicopter operational safety. According to Advisory Circular AC 150/5390-2D, heliport markings must feature a large, clear "H" symbol. This design aims to guide helicopter pilots during landing and takeoff to ensure safe operations.

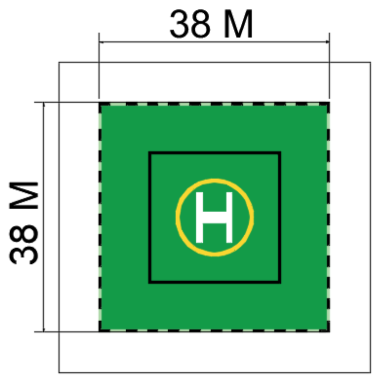



***Figure 12.*** *Marking design*

*4.7 Cost Plan Budget*

The construction of the surface-level heliport at Kolonel Robert Atty Bessing Airport, Malinau includes stages such as site preparation, earthworks, concrete slab construction, and landing area marking installation. All processes are carried out in accordance with the technical standards of PM 78 of 2014 and the Decree of the Regent of Malinau on the Determination and Formulation of Basic Unit Prices for Government Activities of Malinau Regency for Fiscal Year 2025.The Budget Plan is prepared with a total budget of IDR 1,985,066,000.00 (one billion nine hundred eighty-five million sixty-six thousand rupiah), aimed at supporting the improvement of air transportation infrastructure in the border region.

**REKAPTULASI RANCANGAN ANGGARAN BIAYA**

**Jenis Kegiatan : Pekerjaan Surface Level Heliport** **Kabupaten : Malinau**
**Lokasi : UPBU Kolonel Robert Atty Bessing**

| NO | URAIAN PEKERJAAN | VOLUME | SAT. | BIAYA SATUAN UKUR | JUMLAH |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| A | PEKERJAAN PERSIAPAN | | | | |
| A.1 | PEKERJAAN PEMBERSIHAN | 1940,00 | m2 | Rp 6.002,50 | Rp 11.644.850,00 |
| A.2 | PEKERJAAN PENGUKURAN | 1936,00 | m2 | Rp 5.995,79 | Rp 11.607.841,14 |
| A.3 | MOBILISASI DAN DEMOBILISASI | 1,00 | Ls | Rp 15.728.899,00 | Rp 15.728.899,00 |
| | JUMLAH A | | | | Rp 38.981.590,14 |
| B | PEKERJAAN TANAH | | | | |
| B.1 | PEKERJAAN PEMADATAN SUBBASE | 294,27 | m3 | Rp 210.838,42 | Rp 62.043.843,53 |
| | JUMLAH B | | | | Rp 62.043.843,53 |
| C | PEKERJAAN KONSTRUKSI SLAB | | | | |
| C.1 | BEKISTING | 69,00 | m2 | Rp 159.433,28 | Rp 11.000.896,32 |
| C.2 | BAJA TULANGAN DOWEL U-40 | 986,93 | kg | Rp 31.288,00 | Rp 30.879.003,26 |
| C.3 | PEKERJAAN WIREMESH | 4206,60 | kg | Rp 15.075,20 | Rp 63.415.336,32 |
| C.4 | PEKERJAAN LANTAI KERJA | 197,47 | m3 | Rp 2.063.230,43 | Rp 407.430.238,98 |
| C.5 | BETON READYMIX K-350 | 294,27 | m3 | Rp 3.163.994,62 | Rp 931.075.024,82 |
| | JUMLAH C | | | | Rp 1.443.800.499,70 |
| D | PEKERJAAN MARKING | | | | |
| D.1 | PEKERJAAN MARKING | 1444,00 | m2 | Rp 168.643,54 | Rp 243.521.265,75 |
| | JUMLAH D | | | | Rp 243.521.265,75 |
| | | | | TOTAL A+B+C+D | Rp 1.788.347.199,13 |
| | | | | PPN 11% | Rp 196.718.191,90 |
| | | | | GRAND TOTAL | Rp 1.985.065.391,03 |
| | | | | PEMBULATAN | Rp 1.985.066.000,00 |

***Terbilang : satu miliar sembilan ratus delapan puluh lima juta enam puluh enam ribu rupiah.***

## 5. CONCLUSION AND SUGGESTIONS

### *5.1 Conclusion*

The calculation of concrete slab pavement thickness for the surface-level heliport was carried out by comparing two methods: the first using a manual approach based on FAA guidelines, and the second using a numerical method with FAARFIELD software. After a comparative analysis, the FAARFIELD method was chosen as it provides more comprehensive results and aligns with the heliport's operational load. The simulation resulted in a final design with a heliport area of 44 x 44 meters and a concrete slab thickness of 15.2 cm, meeting strength and operational safety standards with the following specifications: Surface Layer: 15.2 cm, Subbase Layer: 15.2 cm, and Subgrade: CBR 8.8%. The next step is to calculate the Cost Estimate (RAB) to determine the required budget for the heliport construction. Based on the detailed work plan and in reference to the Malinau Regent's Decree on the Determination and Formulation of Unit Prices for Government Activities in Malinau Regency for Fiscal Year 2025 and PM 78 of 2014, the total estimated budget is IDR 1,985,066,000 (one billion nine hundred eighty-five million sixty-six thousand rupiah).

### *5.2 Suggestions*

Based on the research conducted and the conclusions drawn, the author recommends expanding future studies beyond pavement thickness calculation, markings, and cost estimation by including a detailed method of working plan for a more structured construction process, as well as developing designs for helicopter movement routes such as taxiways, taxi routes, and parking areas to create a more comprehensive heliport planning.

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