STRUCTURAL DESIGN OF RIGID PAVEMENT SURFACE LEVEL HELIPORT AT SYUKURAN AMINUDDIN AMIR AIRPOT, LUWUK SULAWESI TENGAH

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ABSTRACT

The development of air transportation infrastructure plays a crucial role in enhancing mobility and regional connectivity, especially in remote areas such as Luwuk, Central Sulawesi. One of the essential facilities that require attention is the helipad or heliport, particularly for supporting emergency operations, logistics, and rapid accessibility. This study focuses on the structural planning of a rigid pavement surface-level heliport at Syukuran Aminuddin Amir Airport, aiming to contribute to airport infrastructure development that complies with technical and safety standards. The scientific objective of this research is to design a rigid pavement structure capable of withstanding helicopter loads in accordance with FAA *(Federal Aviation Administration) and relevant Indonesian National Standards (*SNI*), using accurate and efficient design approaches. The methodology integrates traditional design methods (manual analysis based on* SNI*) with modern approaches involving structural analysis software to achieve more precise results. The findings indicate that the designed rigid pavement structure meets the required strength, durability, and cost-effectiveness criteria. The results indicate that the designed pavement structure meets strength, durability, and cost-efficiency criteria, with a surface layer thickness of* 12.7 *cm and a subbase layer thickness of* 15.24 *cm. The heliport's Pavement Classification Number (*PCN*) is* 9.4*, while the helicopter* EC 725 *has a Classification Number (*ACN*) of* 8.9*, with a maximum weight of* 26,299 *pounds. The planned heliport dimensions are* 42 *m x* 42 *m x* 0.2794 *m for the surface volume and* 30 *m x* 30 *m for the marking width. The estimated design cost is* IDR 2.590.000.000,00*. The key contribution of this research is the development of a technically and economically feasible heliport design, which can serve as a reference for similar future developments across Indonesia.*

Keywords: *Heliport, Rigid Pavement, Structural Planning, Luwuk Airport,* FAA, SNI.

INTRODUCTION

Syukuran Aminuddin Amir Airport (IATA: LUW, ICAO: WAFW) is located in Bubung Village, Luwuk District, Banggai Regency, Central Sulawesi. The airport holds a strategic geographical position as it sits atop a hill at an elevation of 17 meters above sea level, parallel to the southern coastline. Since its initial construction in 1972 with a runway measuring 850 x 30 meters, the airport has undergone several phases of development, including a name change in 2008 to honor the last King of Banggai, Syukuran Aminuddin Amir. At present, the airport is equipped with a 2,250 x 45-meter runway, a 315 x 70-meter apron, an 18 x 55-meter taxiway, and a terminal covering 5,000 m², capable of accommodating up to 500 passengers during peak hours. The airport currently serves routes UPG–LUW and PLW–LUW operated by Batik Air and Citilink.

As economic and industrial growth in the Luwuk region—particularly in the mining and fisheries sectors—continues to accelerate, helicopter traffic has also increased significantly. However, the airport currently lacks a dedicated heliport facility, forcing helicopters to land on commercial aircraft aprons. This practice poses several technical issues, such as ground surface depression due to concentrated loading and asphalt surface damage caused by rotor downwash effects. Based on 2024 annual departure data, the EC 725 helicopter, with the highest Maximum Take-Off Weight (MTOW), is identified as the critical helicopter and is therefore used as the reference for heliport design. To optimize the use of the main apron and support safe and efficient operations, a separate heliport is urgently required.

In the planning of this heliport facility, pavement type selection is a crucial consideration. Rigid pavement is preferred due to its superior load-bearing capacity, resistance to overloading, lower maintenance costs, and longer service life compared to flexible pavement. This study aims to design a rigid pavement structure for a Surface Level Heliport capable of withstanding the load of the EC 725 helicopter, with an MTOW of 24,692 pounds. The design is carried out using the methodology recommended by the FAA in Advisory Circular No. 150/5320-6G, with the aid of FAARFIELD software as the standard tool for airfield pavement design. With proper planning and implementation, this heliport facility is expected to enhance the safety and operational efficiency of helicopter movements at Syukuran Aminuddin Amir Airport.

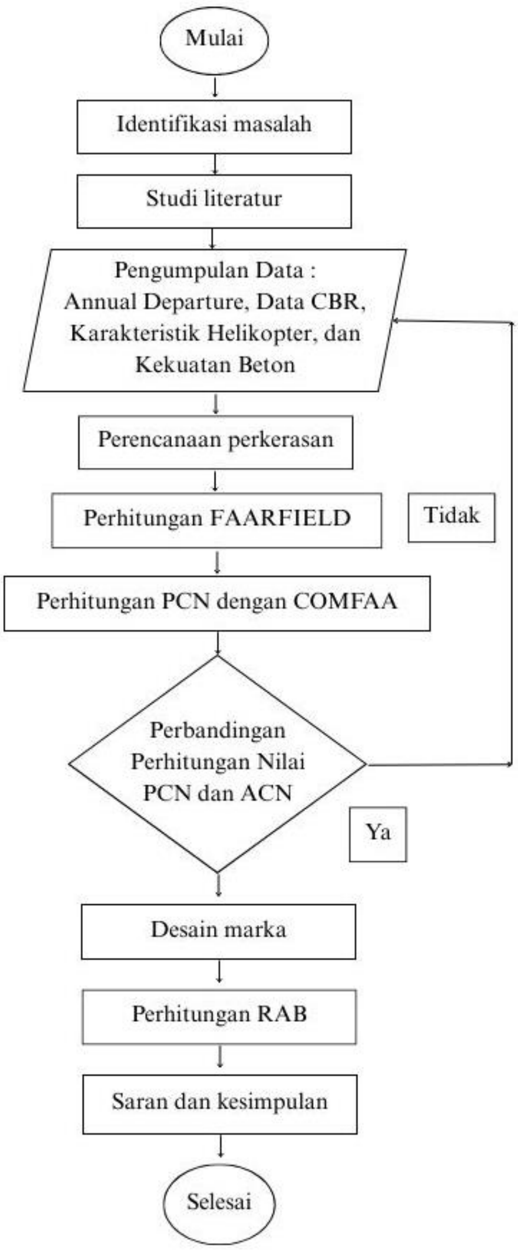
BRIEF THEORY

The design of heliport pavements must consider the unique loading characteristics of rotorcraft, which differ significantly from fixed-wing aircraft. Helicopters apply highly concentrated loads through their landing gear, in addition to dynamic forces generated by rotor downwash. These factors necessitate a pavement structure with high load distribution capabilities. According to FAA Advisory Circular No. 150/5320-6G, rigid pavement is often recommended for heliport applications due to its ability to resist deformation, support concentrated loads, and extend service life with minimal maintenance.

Furthermore, the pavement thickness and structural capacity must be calculated using accurate load modeling. The EC 725, identified as the critical helicopter in this study, has a Maximum Take-Off Weight (MTOW) of 24,692 pounds, which becomes the design input in determining pavement requirements. The FAARFIELD (FAA Rigid and Flexible Iterative Elastic Layered Design) software is used in this study to simulate aircraft-induced pavement stress and fatigue, in accordance with FAA design methodology. This theoretical framework ensures that the heliport structure meets international standards for safety, durability, and operational efficiency.

RESEARCH METHODS

A research flowchart is a visual representation of the steps taken in a research process.



According to the following planning workflow :

- Problem identification

Problem identification is the process of analyzing constraints or issues occurring within the object or scope of a study. The main issue addressed in this research is the absence of a Surface Level Heliport at Syukuran Aminuddin Amir Airport. Currently, helicopters are required to use the existing asphalt-surfaced apron for landing, which is not specifically designed to accommodate rotorcraft operations. This condition can interfere with scheduled commercial aircraft operations and may cause damage to the apron surface due to the concentrated loads and rotor downwash effects from helicopters. Therefore, it is necessary to conduct a study on the planning and design of a Surface Level Heliport using the FAA methodology to ensure safety, durability, and operational efficiency

- . literature study

Data collection through literature study was conducted during On The Job Training (OJT) at Syukuran Aminuddin Amir Airport. The information sources include Government Regulation No. 93 of 2015 on Technical Operational Guidelines and PCN Calculation, FAA Advisory Circulars No. 150/5320-6G on Airport Pavement Design and Evaluation and No. 150/5320-2D on Heliport Design, Government Regulation No. 215 of 2019 on Civil Aviation Safety Standards Part 139 Volume II for Helicopter Landing and Takeoff Sites (Heliports), and ICAO Annex 14 Aerodromes, 2013. These references provide comprehensive technical standards and guidelines used as the basis for the study.

- Data Collection

The data collection process aims to obtain information related to the existing problems, which will subsequently be used to address these issues. In this stage, the author requires several data necessary for the planning of the rigid pavement Surface Level Heliport at Syukuran Aminuddin Amir Airport, including annual departure data, CBR values, helicopter characteristics, and HSPK data for the Luwuk region, Central Sulawesi.

- Pavement Palnning

Currently, Syukuran Aminuddin Amir Airport does not have a Surface Level Heliport, and helicopters land directly on the asphalt apron, which causes damage due to frequent landings and RON operations. To prevent further deterioration and comply with regulations, a Surface Level Heliport is planned using rigid pavement. This facility aims to accommodate the largest arriving helicopters without disrupting scheduled aircraft activities. The planning process involves several stages, beginning with a literature review to gather relevant theories and formulas related to FAARFIELD and COMFAA calculations, followed by collecting primary and secondary data such as annual departure statistics, California Bearing Ratio (CBR) values at the airport, helicopter characteristics, and the concrete strength to be used.

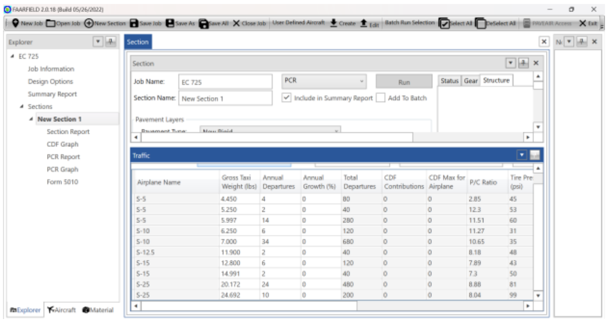
- FAARFIELD

According to FAA Advisory Circular 150/5320-6G, FAARFIELD is an application developed by the FAA based on failure models derived from full-scale testing since the 1940s. The general steps for using FAARFIELD are as follows:

1. Open the FAARFIELD application and select the desired pavement type.

2. Modify the pavement structure by adding, removing, or changing layers according to aircraft data.

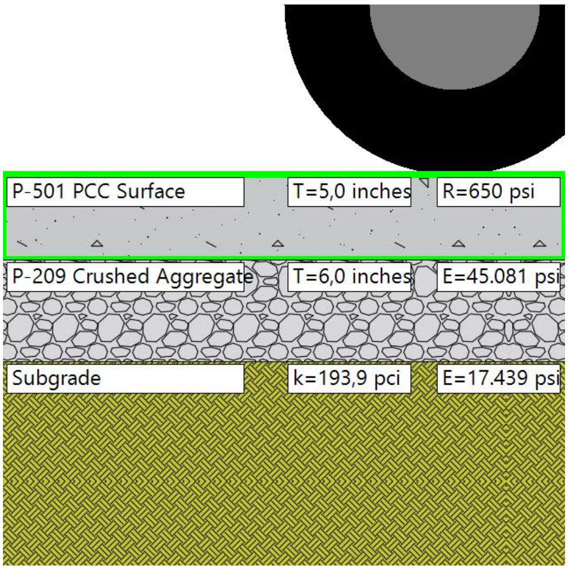
3. Create a traffic mixture by selecting existing data or choosing aircraft from the database.



4. If necessary, adjust the aircraft gross weight or the number of flights in the traffic mixture.

5. Run the “thickness design” option.

6. Perform compaction/aging simulation to obtain the required subgrade compaction for new pavement construction.



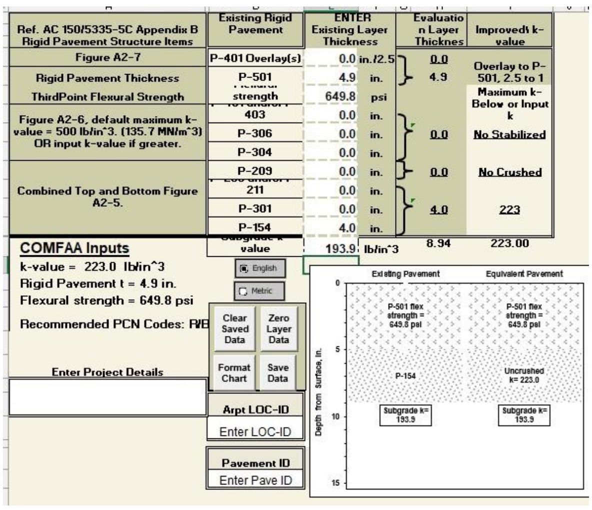
7. Review the design results or print the design report generated by the program.

- PCN calculation with COMFAA

After calculating pavement thickness using FAARFIELD software, the pavement thickness results are as follows:

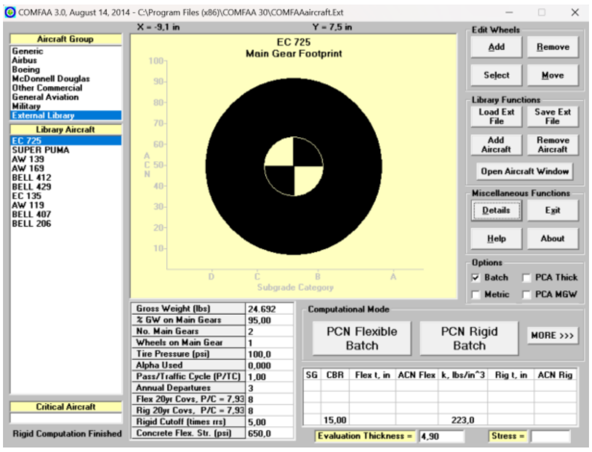
- Subgrade k-value = 193.9 kN/m³
- Subbase thickness = 6 inches
- Concrete slab thickness = 5 inches

Next, the pavement thickness was calculated using the built-in spreadsheet of COMFAA software to determine the k-value by inputting the subgrade k-value, which will then be used in the COMFAA application, as shown in the figure below:



- COMFAA calculation

After determining the k-value and the thickness of the rigid pavement, the next step is to proceed with the application of the COMFAA software.



Aircraft Data - C:\Program Files (x86)\COMFAA 30\COMFAAaircraft.Ext

No.	Aircraft Name	Gross Weight (lbs)	Percent GW on Gears	Tire Press. (psi)	Annual Departures	No. of Tires on Gear	Number of Gears
1	EC 725	24.692	95,00	100,0	3	1	2
2	SUPER PUMA	20.172	95,00	50,0	6	1	2
3	AW 139	14.991	95,00	50,0	1	1	2
4	AW 169	12.800	95,00	50,0	2	1	2
5	BELL 412	11.900	95,00	50,0	1	1	2
6	BELL 429	7.000	100,00	50,0	9	1	1
7	EC 135	6.250	100,00	50,0	2	1	1
8	AW 119	5.997	100,00	45,0	4	1	1
9	BELL 407	5.250	100,00	45,0	1	1	1
10	BELL 206	4.450	100,00	45,0	1	1	1

```
This file name = PCN Results Rigid 5-30-2025 19;11;32.txt
Library file name = C:\Program Files (x86)\COMFAA 30\COMFAAaircraft.Ext
Units = English

Evaluation pavement type is rigid
Equivalent coverages computed with the AC 150/5320-6C/D edge stress design method.
Maximum gross weight computed with the AC 150/5320-6C/D edge stress design method.

                    k Value = 223,0 lbs/in^3 (Subgrade Category is B(295))
               flexural strength = 650,0 psi
         Evaluation pavement thickness = 4,90 in
     Pass to Traffic Cycle (PtoTC) Ratio = 1,00

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

Results Table 1. Input Traffic Data
                          Gross   Percent    Tire     Annual     20-yr    6D
 No. Aircraft Name        Weight  Gross Wt   Press     Deps    Coverages Thick
-------------------------------------------------------------------------------
  1  EC 725               24.692   95,00     100,0       3          8    4,76
  2  SUPER PUMA           20.172   95,00      50,0       6         19    3,83
  3  AW 139               14.991   95,00      50,0       1          3    3,12
  4  AW 169               12.800   95,00      50,0       2          5    2,99
  5  BELL 412             11.900   95,00      50,0       1          2    2,81
  6  BELL 429              7.000  100,00      50,0       9         25    3,37
  7  EC 135                6.250  100,00      50,0       2          5    3,03
  8  AW 119                5.997  100,00      45,0       4         11    2,97
  9  BELL 407              5.250  100,00      45,0       1          3    2,65
 10  BELL 206              4.450  100,00      45,0       1          2    2,46
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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     B(295)
-------------------------------------------------------------------------------------------------
  1  EC 725                      8         4,76       26.299        5,73      0,4685      9,4
  2  SUPER PUMA              5.874         4,66       22.665        4,72      0,0015      6,2
  3  AW 139                 50.441         4,69       16.555        4,10      0,0000      4,6
  4  AW 169                179.310         4,71       14.043        3,80      0,0000      3,9
  5  BELL 412              331.480         4,71       13.018        3,68      0,0000      3,7
  6  BELL 429               57.611         4,69        7.725        4,06      0,0002      4,5
  7  EC 135                142.885         4,70        6.864        3,85      0,0000      4,1
  8  AW 119                343.108         4,71        6.574        3,70      0,0000      3,7
  9  BELL 407            1.108.708         4,72        5.712        3,47      0,0000      3,2
 10  BELL 206           >5,000,000         4,74        4.813        3,22      0,0000      2,8
                                                               Total CDF =  0,4703

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    B(295)
------------------------------------------------------------------------
  1 EC 725                24.692    95,00     100,0      5,57      8,9
  2 SUPER PUMA            20.172    95,00      50,0      4,48      5,6
  3 AW 139                14.991    95,00      50,0      3,92      4,2
  4 AW 169                12.800    95,00      50,0      3,65      3,6
  5 BELL 412              11.900    95,00      50,0      3,53      3,4
  6 BELL 429               7.000   100,00      50,0      3,89      4,1
  7 EC 135                 6.250   100,00      50,0      3,69      3,7
  8 AW 119                 5.997   100,00      45,0      3,55      3,4
  9 BELL 407               5.250   100,00      45,0      3,34      3,0
 10 BELL 206               4.450   100,00      45,0      3,10      2,6
```

Based on the results obtained from the FAARFIELD and COMFAA applications for PCN value and pavement thickness, the following data were found:

- Subbase thickness: 6 inches
- Concrete slab thickness: 5 inches

- Total thickness: 11 inches
- Subgrade K-value: 193.9 lb/in³
- Maximum Allowable Gross Weight: 26,299 pounds

From the FAARFIELD and COMFAA calculations, the ACN value for the EC 725 helicopter is 8.9, and the PCN value is 9.4. Since the PCN is greater than the ACN, the pavement design meets the required criteria, with a CDF value of 0.4685.

- Reinforcement Calcualtion

The formula used to determine the required steel reinforcement area (As) in rigid pavement is:

$$As = \left(\frac{\mu\ x\ L\ x\ M x\ g\ x\ h}{2\ x\ fs}\right)$$

Where:

- AsAs = steel reinforcement cross-sectional area (mm^2 per meter width of slab)
- fsfs = allowable tensile stress of reinforcement (MPa)
- gg = acceleration due to gravity (m/s^2)
- hh = thickness of concrete slab (m)
- LL = length of concrete slab (m)
- MM = weight per unit volume of slab (kg/m^3)
- μ = coefficient of friction between concrete slab and subgrade

From previous calculations, the parameters are given as:

- Slab thickness (hh) = 12.7 cm = 0.127 m
- Planned slab width = 45 m
- Planned slab length (LL) = 45 m
- Coefficient of friction (μμ) = 1.5
- Tensile stress of steel reinforcement (fsfs) = 280 MPa
- Density of concrete (MM) = 2400 kg/m^3
- Gravity acceleration (gg) = 9.81 m/s^2

The calculated area of steel reinforcement (As) is:

$$As = \left(\frac{\mu\ x\ L\ x\ M x\ g\ x\ h}{2\ x\ fs}\right)$$

$$As = \left(\frac{1{,}5\ x\ 45\ x\ 2400\ x\ 9{,}81\ x\ 0{,}127}{2\ x\ 280}\right)$$

$$= 360{,}4124\ mm^2/m$$

$$As_{min} = 0{,}14\%\ x\ h\ x\ 1000$$

$$= 0{,}14\%\ x\ 127\ mm\ x\ 1000$$

$$= 177{,}8\ mm^2/m$$

It is obtained that:

$Asmin < As \rightarrow 177.8\ mm^2/m < 360.4124\ mm^2/m$

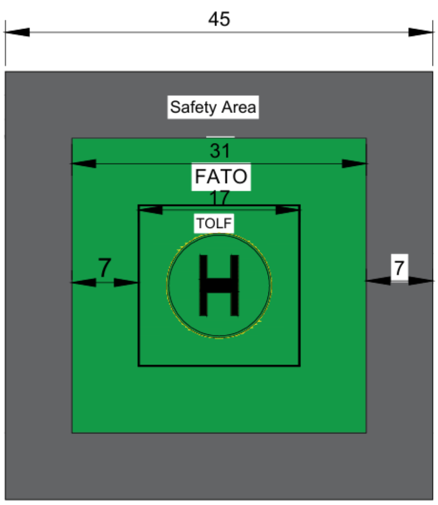
The concrete reinforcement is planned using BjTS 280 steel with a yield strength (fy) of 280 MPa. The design uses deformed wire mesh D-8 bars spaced at 150 mm intervals. This choice provides adequate strength while considering installation efficiency on-site and complies with the design standards of SNI 2847:2019.

- Dowel Calculation

The slab thickness calculated using the FAARFIELD application is 5 inches. According to the AC No: 150/5320-6G table, dowels with a diameter of 20 mm, length of 46 cm, and spacing of 30.5 cm are used.

- Marking

Based on AC 150/5390-2D, the design and dimensions of each pavement marking were determined.



- The Budger Plan

The Budget Plan for the Surface Level Heliport rigid pavement is a crucial component in the construction planning stage, aimed at comprehensively calculating all costs based on technical specifications and work volume. It involves identifying work types, units, analysis coefficients, and unit prices for materials and labor. For heliport pavement works, the estimated items include subgrade preparation, foundation layers, reinforced concrete pavement, reinforcement installation, finishing works, and landing area markings. All cost components are calculated according to applicable standards such as SNI, AHSP, and regional HSPK to ensure realistic and accountable estimates. The RAB serves as a basis for project owners to allocate budgets and control expenditures during construction, minimizing cost deviations and enhancing project transparency. Additionally, it is essential for tendering, contractual processes, and cost evaluation throughout project execution. Therefore, accuracy in preparing the RAB is vital for the overall efficiency and success of the heliport pavement construction project.

NO	URAIAN PEKERJAAN	VOLUME	SAT.	BIAYA SATUAN UKUR	JUMLAH	
1	2	3	4	5	6	
I	PEKERJAAN PEMBERSIHAN	2.026,00	m2	139.848,79	Rp	283.333.640,44
II	PEKERJAAN PENGUKURAN	2.026,00	m2	15.859,82	Rp	32.132.005,04
III	MOBILISASI DAN DEMOBILISASI	2,00	Ls	2.055.648,00	Rp	4.111.296,00
IV	PEKERJAAN BEKISTING	125,73	m2	355.459,53	Rp	44.691.926,20
V	BETON SEMEN BERTULANG MUTU K-350	257,18	m3	2.075.101,66	Rp	533.664.270,57
VI	PEKERJAAN WIREMESH	11.060,41	kg	72.248,96	Rp	799.103.086,49
VII	PEMBESIAN DOWEL	3.891,89	kg	143.219,46	Rp	557.394.082,66
VIII	PEKERJAAN MARKING	961,00	m2	82.097,95	Rp	78.896.128,03
		SUB TOTAL			Rp	2.333.326.435,43
		PPN 11%			Rp	256.665.907,90
		GRAND TOTAL			Rp	2.589.992.343,33
		PEMBULATAN			Rp	2.590.000.000,00
Terbilang :		*Dua Miliar Lima Ratus Sembilan Puluh Juta Rupiah*				

CONCLUSION

a. Conclusion

Based on the data that has been analyzed and calculated, the following results can be concluded:

1. The results of the total thickness calculation of the Surface Level Heliport pavement structure using COMFAA and FAARFIELD software for the design of the Surface Level Heliport are as follows:

- Concrete slab thickness: 5 inches
- Subbase thickness: 6 inches
- Reinforcement: D8-150 threaded wire mesh
- PCN (Pavement Classification Number): 9.4
- ACN (Aircraft Classification Number): 8.9
- CDF (California Damage Factor): 0.4685

2. From the calculation of the dimensions and concrete slab of the Surface Level Heliport, the Budget Plan (RAB) is obtained at IDR 2,590,000,000.00 (Two Billion Five Hundred Ninety Million Rupiah). This calculation includes all materials and work required for the construction of the concrete slab.

b. Sugesstion

From the calculation of the dimensions and concrete slab of the Surface Level Heliport, the Budget Plan (RAB) is obtained at IDR 2,590,000,000.00 (Two Billion Five Hundred Ninety Million Rupiah). This calculation includes all materials and work required for the construction of the concrete slab.

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