OVERLAY THICKNESS PLANNING ANALYSIS FLEXIBLE PAVEMENT RUNWAY TORAJA AIRPORT SOUTH SULAWESI

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ABSTRACT
Toraja Airport is an airport located in Tana Toraja Regency, South Sulawesi Province. The airport has a runway with dimensions of 2000 m x 30 m and the most critical aircraft, the ATR 72-600. Currently, Toraja Airport has problems, namely Weathering and Raveling on the runway surface. Therefore, further handling is needed in the form of overlays to prevent bad things from happening in flight operations. This study aims to determine the needs and plan the thickness of the overlay on the runway of Toraja Airport. This study uses the FAARFIELD (Federal Aviation Administration Rigid and Flexible Iterative Elastic Layer Design) method. In this study, several stages were carried out. The stages include overlay planning with FAARFIELD and calculating the Draft Budget Cost for the Toraja Airport runway overlay work. The results of this study show that the overlay planning covers the entire runway area of 2000 m x 30 m. The overlay thickness requirement on the runway of Toraja Airport is 50.8 mm or equivalent to 5 cm. Based on the Cost Budget Plan that has been made, the cost is IDR 4,957,900,000.00 (four billion nine hundred and fifty-seven million nine hundred thousand rupiah).

Keywords: *Runway, Overlay, FAARFIELD, Draft Budget Cost, Weathering and Raveling*.

INTRODUCTION

Toraja Airport (IATA: TRT, ICAO: WAFB), formerly Buntu Kunik Airport, is one of the air transportation access facilities in Tana Toraja Regency, South Sulawesi. Geographically, Toraja Airport is located at 03°11'08"S and 119°55'02"E respectively. Toraja Airport is located about 11 km from Makale, and 287 km from Makassar City. Toraja Airport has runway dimensions of 2000 x 30 m with PCN 15 F/C/Y/T.

Toraja Airport serves several flight routes, namely TRT-UPG, TRT-BPN, and TRT-SKO. For airlines serving Toraja Airport, namely Wings Air, Citilink, and Susi Air. In aviation activities, Toraja Airport serves flights with the most critical aircraft today, namely the ATR-72 600.

In serving these flight activities, Toraja Airport must of course ensure that its facilities and infrastructure meet the standards. One of the main infrastructure in aviation activities is the runway. Maintenance of the runway pavement needs to be carried out with the aim of preventing bad things that occur in flight operations and more severe pavement damage due to damage to the runway pavement [1].

At the beginning of 2024, Toraja Airport held a survey to assess the damage to the runway pavement at Toraja Airport.

In assessing the type of damage and the right handling, *the Pavement Condition Index* (PCI) is one of the commonly used methods [2]. The visual inspection-based method is a practical and effective approach for obtaining accurate data in the field regarding the condition of pavement surfaces. By directly identifying and documenting the type and extent of damage present on the pavement, this method allows for a precise calculation of the Pavement Condition Index (PCI). The PCI value is a critical metric that reflects the overall condition of the pavement and helps in planning appropriate maintenance or repair actions.

One of the significant advantages of this method is its adaptability and efficiency, making it suitable for evaluating pavement conditions regardless of the survey location. The visual inspection technique does not necessitate the use of specialized or cumbersome equipment, which is particularly beneficial for conducting surveys in remote or less accessible areas. This flexibility allows for comprehensive assessments even in locations that are distant from urban centers, where access to advanced technology or machinery might be limited.

Furthermore, the visual inspection method is cost-effective compared to more technologically advanced methods that require expensive equipment and extensive logistical support. It relies on the expertise of trained personnel who can visually assess and categorize pavement distress, making it an accessible option for a wide range of projects. This approach facilitates timely and accurate evaluations, ensuring that pavement management strategies can be implemented effectively without the need for high-tech tools.

Overall, the visual inspection-based method provides a reliable and straightforward means of assessing pavement conditions, offering valuable insights into the necessary maintenance requirements and contributing to the efficient management of pavement infrastructure.

From the results of the *Pavement Condition Index* (PCI) survey, it was found that the average PCI value of the runway at Toraja Airport was classified on a poor scale with an average value of 43.75. The runway conditions at Toraja Airport are currently experiencing *Weathering and Ravelling* and Depression on the runway surface.

Based on the data above, it can be seen that *Weathering and Ravelling* damage dominates on the runway surface of Toraja Airport. This damage requires further handling to prevent bad things from happening in flight operations. In addition, this pavement damage needs to be handled to avoid more severe pavement damage due to damage to the runway pavement [3].

In the event of Weathering *and Ravelling* damage: if the condition is low, the follow-up carried out is cleaning and routine observation. Meanwhile, if the condition is medium to high in a small area, local cutting (*patching*) is carried out perpendicular to the thickness of the surface layer, and the asphalt hotmix mixture is used in accordance with technical specifications. In the case of medium to high conditions in a large area, further handling is in the form of overlays.

METHOD

Figure 1 Research Flow Chart

Primary Data

This study also used primary data in the form of the results of the Pavement Condition Index (PCI) survey on the runway of Toraja Airport in 2024. The results of this survey are based on the results of visual observation analysis using the latest PCI method of damage to the runway of Toraja Airport.

Secondary Data

In this study, several secondary data sources are essential, including detailed information on runway characteristics, which provide a foundation for accurate analysis. Additionally, data on the most critical aircraft, specifically the ATR 72-600, are crucial for assessing the runway's suitability and performance under typical operating conditions. Furthermore, the Standard Unit Price of Wages and Materials in Tana Toraja Regency for 2023 is necessary to ensure that cost estimates are accurate and reflect current economic conditions in the region.

In this study secondary data were used, namely the Toraja Airport runway data as follows:

- Pavement type: Flexible Pavement
- Strength: PCN 15 F/C/Y/T
- Dimension: 2000 x 30 meters

Overlay Thickness Area Planning

Determining the extent of overlay needs can be effectively done by analyzing the results of the Pavement Condition Index (PCI) survey. This method provides crucial insights into the current state of the pavement, enabling engineers to identify areas that require immediate attention. The types of damage identified in the PCI survey each have different methods of effective handling, depending on the severity and nature of the deterioration.

Pavements that exhibit a PCI value of 45 or lower are considered to be in critical condition and must immediately receive further treatment to prevent further degradation [4]. This threshold is essential for maintaining the safety and functionality of the pavement, especially in high-traffic areas like runways, where even minor issues can lead to significant operational challenges.

Early intervention based on PCI results not only prolongs the pavement's lifespan but also optimizes maintenance costs by addressing problems before they escalate. Therefore, regular PCI assessments are a key component in a comprehensive pavement management system.

Overlay Thickness Planning with the FAARFIELD Method

FAARFIELD (Federal Aviation Administration Rigid and Flexible Iterative Elastic Layered Design) is a software used in designing the pavement structure of airside facilities. Planning with FAARFIELD software is in accordance with the rules contained in FAA document 150/5320-6G.

This software can be used to determine the pavement thickness required to support various aircraft traffic loads, both rigid and flexible pavements [5]. FAARFIELD creates ideal designs that meet safety and operational efficiency standards by incorporating various analytical models and empirical data from field research results. Aircraft traffic data, pavement material properties, and relevant environmental conditions are entered when in use.

In the calculation planning using the FAARFIELD method, using the concept of Cumulative Damage Factor (CDF). This Cumulative Damage Factor (CDF) is the fatigue value of a pavement structure caused by the load received during the service period [6]. CDF has 3 value ranges. CDF = 1 means that the pavement can be used during the service life and suffers damage after the service life is exhausted. CDF<1 means that the pavement can still be used after the service life has expired. While CDF>1 means that the pavement is damaged before the service life is exhausted.

In general, here are the steps in operating FAARFIELD software.

1. Create a *job file* by going to the "*New Job"* menu and naming the *"Job Name"* and *"Section Name" sections*. This process begins by opening the program and selecting the "New Job" menu. The user will then be prompted to name the project file, which is a crucial step for organization and clarity. In the "Job Name" section, the user should enter the name of the project to ensure that it is easily identifiable. Additionally, in the "Section Name" field, the user should specify the relevant part of the pavement that is being designed. This ensures that all design elements are accurately categorized and tracked throughout the project. Properly naming and categorizing these components helps maintain organization and facilitates efficient project management [7].
2. Make modifications to the type of pavement. Users can choose the type of pavement that best aligns with the specifications of the project they are working on. This selection is crucial because it directly influences both the strength and durability of the planned structure. Different types of pavement have varying properties, such as load-bearing capacity, resistance to environmental factors, and overall lifespan. Choosing the appropriate pavement type ensures that the final structure will meet the required performance standards and effectively handle the anticipated loads and stresses. The correct choice contributes to the longevity and maintenance of the pavement, minimizing future repair needs and extending the service life of the infrastructure [8]. Proper selection not only optimizes the performance of the pavement but also ensures that the project remains within budget and meets safety and regulatory requirements.
3. Make modifications to the pavement layer structure. Next, the user needs to carefully adjust the pavement layer structure according to the specific project specifications. This process involves setting the appropriate thickness and selecting the right material for each layer, starting from the surface layer down to the base layer. Each layer’s properties must be accurately defined to ensure the pavement meets the required performance standards [9]. Users can access the dedicated menu within the software to modify the structure of the pavement layer, where they can enter crucial details such as the thickness of the asphalt layer, type of materials used, and other important material characteristics. These adjustments are essential for tailoring the pavement design to the unique demands of the project, ensuring durability and long-term functionality.
4. Input the type of aircraft as well as *annual departure* and *annual growth* in the "*Aircraft*" menu. The fourth step is to gather information about aircraft traffic. Go to the *"Aircraft"* menu and enter the type of aircraft you want to use on the runway. The inputs for each type of aircraft are the number of annual departures and the annual growth rate [10].
5. Input the life of the plan in the "*Design life*" menu. Design Life refers to the period during which a pavement is expected to function efficiently without requiring significant rehabilitation or improvements [11]. This timeframe is crucial as it dictates the long-term performance and durability of the pavement under anticipated traffic and environmental conditions. Users have the flexibility to input the Design Life that aligns with their specific project requirements, ensuring that the pavement structure is tailored to meet expected usage demands. By entering the appropriate Design Life, users can accurately plan for the pavement’s longevity, balancing initial construction costs with long-term maintenance considerations. This approach helps in optimizing the overall lifecycle costs while maintaining the desired performance standards throughout the pavement’s intended lifespan.
6. Carry out the final design of the pavement structure. This finalization can be done by clicking on the "*Run*" menu in the "*Section*" area. Users can start the final analysis after all the data has been entered and changed. To start the analysis process, users can select the *"Section" area* and click the *"Run"* menu. FAARFIELD will calculate and provide the best design results based on user input [12].

Draft Budget Cost Calculation

The Draft Budget Cost (DBC) is an essential financial tool used to estimate the costs required for each component of a construction project [13]. This plan provides a detailed breakdown of all the expenses involved, ensuring that every aspect of the project is accounted for financially. By using the Draft Budget Cost, project managers and stakeholders can determine the total cost necessary to complete the project, enabling effective budgeting and financial management.

The Draft Budget Cost is derived from the results of overlay thickness planning and the calculation of work volume, which are based on the Standard Unit Price of Wages and Materials in Tana Toraja Regency for the year 2023. This approach ensures that the cost estimates reflect current local economic conditions, providing a realistic and accurate financial framework for the project.

In the context of overlay planning, the Draft Budget Cost helps to estimate costs related to materials, labor, equipment, and any other resources required for the overlay work. By incorporating the standard unit prices, the Draft Budget Cost not only facilitates accurate budgeting but also helps in identifying potential cost-saving opportunities. Ultimately, a well-prepared Draft Budget Cost ensures that the project can be executed within its financial constraints, supporting successful project completion and effective resource management.

RESULT AND DISCUSSION

Overlay Thickness Area Planning

In the dominant damage condition observed on the Toraja Airport Runway, Weathering and Ravelling were identified as the most prevalent issues. Given the widespread occurrence of these types of damage, applying an overlay is considered the most appropriate and effective further treatment. Overlaying not only addresses the immediate surface damage but also extends the lifespan of the pavement by providing an additional protective layer that shields the underlying structure from further deterioration. This approach is particularly crucial in areas where surface wear is significant, ensuring the runway remains safe and operational for aircraft landings and takeoffs.

In contrast to the extensive Weathering and Ravelling, the damage observed in the form of Depression on the runway was relatively minor, classified as Low-level damage. Depressions were only detected at two specific points within one of the stationing sections, specifically STA 0+400 – 0+500. The accumulation of depressions at these locations was minimal, with a small total density and a deduct value of 0, indicating a negligible impact on overall pavement performance. Despite the low severity, addressing these depressions through patching is still recommended to prevent any potential progression of the damage and to maintain the uniformity of the runway surface [14].

The following is the breakdown of the percentage of damage types and their corresponding levels across the entire runway area, which spans 2,000 meters in length and 30 meters in width. This detailed assessment highlights the distribution and severity of different pavement issues, providing a comprehensive overview that informs the necessary maintenance strategies for the Toraja Airport Runway. By understanding the specific conditions and damage levels, targeted interventions can be effectively planned and executed to ensure the runway remains in optimal condition.

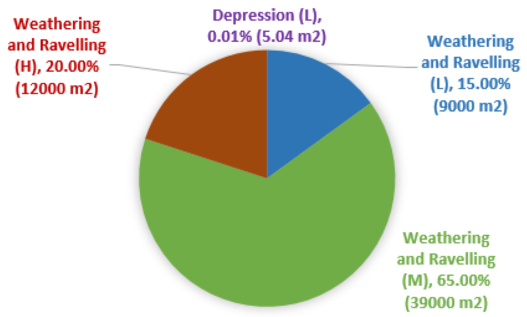

Figure 2 Runway Damage Area Percentage

Overlay Thickness Planning with the FAARFIELD Method

1. Create a *job file* by going to the *"New Job"* menu and naming the *"Job Name"* and *"Section Name" sections.*

   The first step that needs to be done in this process is to create a job file that will be the basis for planning. This job file can be created through the "New Job" menu available in the software. To facilitate job identification and management, it is highly recommended to provide clear names in the "Job Name" and "Section Name" sections. In this stage, the job file was given the name "Overlay Runway Toraja," which reflects the goal of the project, which is to resurface the runway at Toraja Airport. Meanwhile, for the sample section, it is given the name "AconFlex," which may refer to the type of material or method used in planning. With this initial step, all the data and project settings can be well organized, facilitating further planning processes. For the initial view, it can be seen as follows.

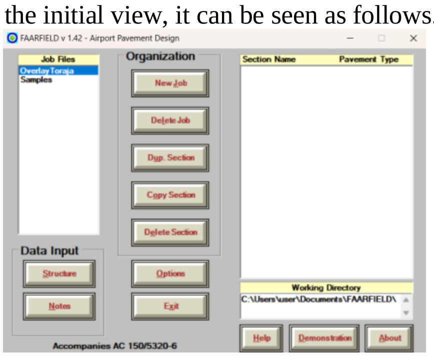

Figure 3 Initial View of Job File Creation

2. Make modifications to the type of pavement.

   The next step is to determine the type of pavement to be used in the menu section. Given that this study focuses on the planning of the thickness of the re-coating for the bending pavement, the authors need to choose the type of pavement that suits the project specifications. At this stage, the author will input the relevant type of flexural pavement in the system. The selection of the right type of pavement is very important because it will affect the calculation of the overlay thickness as well as the final performance and durability of the planned runway pavement. By including accurate data regarding the type of pavement, the planning process can be carried out effectively and according to the needs of the project. Regarding the research carried out is a re-layered thick planning on the flexural pavement, the type of pavement that the author inputs is AconFlex (Asphalt overlay on Flexible pavement).

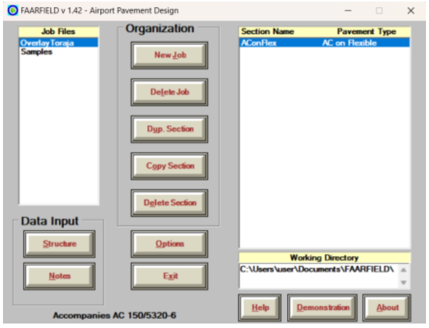

Figure 4 Pavement Type Modification

3. Make modifications to the pavement layer structure.

On the sample "AconFlex01," the authors made deep modifications to the pavement structure to ensure that the pavement design corresponds to the existing characteristics of the runway and the specific needs of the planned critical aircraft, namely the ATR 72-600 with a maximum operating weight of 23,000 kg. This modification involves adjusting the thickness of the pavement layer, selecting the appropriate type of material, and designing the overall structure of the pavement layer. The purpose of these changes is to ensure that the runway can effectively support the load generated by the aircraft as well as its day-to-day operations.

Adjustment of the thickness of the coating is important to cope with the structural loads imposed by the aircraft, while the selection of the right material ensures durability and resistance to environmental factors that may accelerate damage. Modifications to the pavement layer structure are designed to improve runway performance, reduce the possibility of damage, and ensure that the runway remains in optimal condition throughout its operating life.

By making these adjustments, the authors aim to optimize the performance and durability of the runway, as well as ensure that all necessary safety and efficiency standards are met. The updated re-layering planning process aims to provide a stronger and more reliable runway, thus supporting the aircraft's proper operation and minimizing the need for additional maintenance in the future. This approach not only improves the quality of the runway but also aids in long-term planning for sustainability and operational efficiency.

The existing data on runway characteristics are as follows.

Table 1 Existing Runway Pavement Structure

No.	Structure	Description	Structure	Thickness
1.	P-401/P-403	*Plant Mix Bituminous Pavements* (HMA)	*Surface*	*100 mm*
2.	P-209	*Crushed Aggregate Base Course*	*Base Course*	*250 mm*
3.	P-154	*Subbase Course*	*Subbase*	*350 mm*
4.	*Subgrade CBR 6%*			

The following is the appearance of FAARFIELD as a result of the modification of the pavement structure.

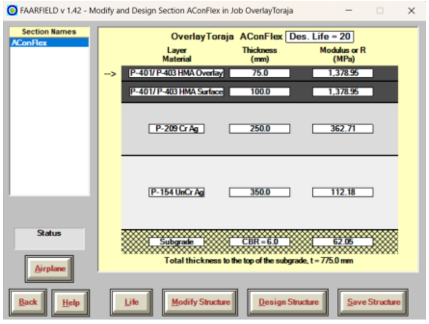

Figure 5 Pavement Structure Modification

4. Input the type of aircraft as well as *annual departure* and *annual growth* in the "*Aircraft*" menu.

In this menu, it is important to select and adjust the type and characteristics of the aircraft, especially the ATR 72-600. This process is directly related to the determination of annual departure and the calculation of annual growth. Annual departure refers to the number of aircraft departures that occur during a period of one year, providing an overview of the operational volume of aircraft at the airport. Meanwhile, annual growth is the percentage increase in the number of aircraft or flight frequency from year to year, reflecting a growth trend or decreased activity at the airport. Compiling this data accurately is critical for effective planning, as it influences decisions regarding pavement capacity and long-term maintenance strategies of the runway.

In determining annual growth, it can be calculated as the formula listed below.

$$Annual\ growth = \frac{(P_n - P_{n-1})}{P_{n-1}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Notes:

P_n = Aircraft movements of the year

P_{n-1} = Aircraft movements of the previous year

Before calculating the annual growth of ATR 72-600 aircraft at Toraja Airport in the last year (2023), we need to first know the annual departure data of ATR 72-600 aircraft at Toraja Airport in the last few years.

The following is the annual departure data of ATR 72-600 aircraft at Toraja Airport in the period of 2020-2023.

Table 2 Annual Departure Data of ATR 72-600

YEAR	ATR 72-600
2020	119
2021	216
2022	227
2023	252

From the calculation based on equation (1), the annual growth ATR 72-600 in 2023 is 11%. Because it is 11% > 10%, the annual growth ATR 72-600 in 2023 is inputted at 10%. This is because the annual growth range allowed at FAARFIELD is starting from -10% to 10%.

Because there is no type of ATR 72-600 aircraft in the FAARFIELD aircraft list, the author converts the ATR 72-600 aircraft with the generic aircraft list that has been provided by FAARFIELD. The author converted the ATR 72-600 aircraft to the D-50 aircraft on the generic menu. The justification for the selection of the D-50 as a conversion of the ATR 72-600 aircraft is because the D-50 aircraft has a dual wheel meaning on the main gear MTOW of 50,000 lbs. The D-50 aircraft is in accordance with the characteristics of the ATR-72 600 aircraft, namely dual wheels on the main gear MTOW of 50,706 lbs / 23,000 kg [15].

After doing these steps, the next step that the author will do is to input data according to the detailed table of data input for the critical aircraft. The following is FAARFIELD's appearance at the input stage of aircraft type, annual departure, and annual growth.

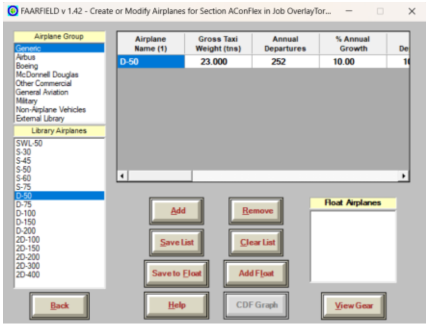

Figure 6 Modification of Aircraft Types and Characteristics

5. Input the life of the plan in the "*Design life*" menu.

   In the "Design Life" menu, the author refers to FAA regulation 150/5320-6G to ensure compliance with applicable standards. Based on the guidelines in FAA 150/5320-6G, recoat thickness planning should be designed with a minimum plan life of 20 years. This regulation provides important guidelines for determining a long enough design period, ensuring that runway pavements will continue to function optimally and efficiently for the next two decades. Planning with the right plan life not only affects the long-term performance of the runway but also helps in planning future maintenance and repairs, maintaining safety and operational performance.

   The following is FAARFIELD's appearance from the modification of the age of the research plan to re-layer the runway at Toraja Airport.

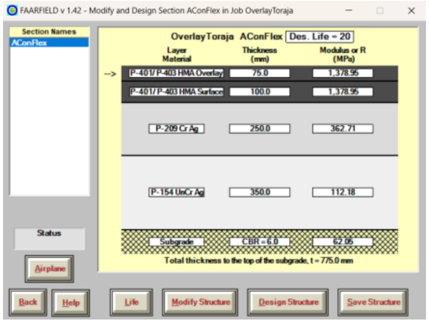

Figure 7 Design Life

6. Carry out the final design of the pavement structure.

   Finalizing this planning process can be done by clicking on the "Run" menu located in the "Section" area. This will trigger the software to run all the calculations that have been set, processing all the data and parameters that have been inputted. The results of this process will produce the required final output, providing the complete information needed to proceed to the next stage in pavement re-layering planning and analysis.

   The following are the results of the finalization of the overlay on FAARFIELD.

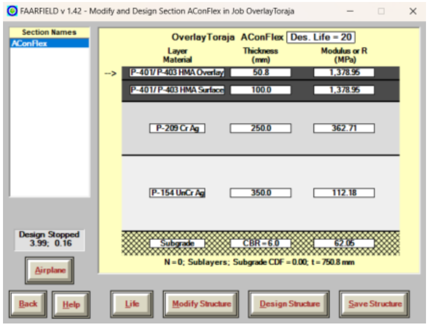

Figure 8 The Final of FAARFIELD

From the implementation of the operation of the FAARFIELD software, results were obtained that showed that the Cumulative Damage Factor (CDF) value was 0.00. This large CDF value indicates that the pavement structure of the runway is in excellent condition and does not experience fatigue. With this value, it can be concluded that the pavement structure is able to withstand operational loads without showing signs of significant damage or deterioration in performance. This condition shows that the runway pavement is still in an optimal state and does not require major repairs to continue its operational function.

Based on these results, the FAARFIELD software recommends a minimum overlay layer thickness of 50.8 mm, or the equivalent of 5 cm. This thickness is designed to ensure that the applied overlay is sufficient to extend the life of the runway pavement, while avoiding excessive additional load on the existing structure. Overlays of this thickness are considered adequate to protect and repair the runway surface without causing excessive stress on the underside.

The use of the minimum recommended overlay thickness in project planning has significant benefits, especially when it comes to cost management. When the right overlay thickness is followed, the project can optimize the use of the necessary materials and resources, thereby reducing the possibility of overspending. By applying the minimum recommended overlay thickness, projects can minimize material costs without sacrificing the quality or performance of the pavement layer. This prevents the purchase of additional materials that may not be necessary and ensures that the project budget remains well controlled.

In addition, efficient cost management contributes to more sustainable planning. By determining the optimal overlay thickness, the project can reduce the environmental impact and extend the life of the pavement. The appropriate thickness of the overlay also helps in minimizing the need for long-term maintenance, thereby reducing the frequency and cost of future maintenance. This not only saves costs but also supports more environmentally friendly construction practices.

The application of the minimum recommended overlay thickness ensures that the project meets the expected safety and performance standards. Adequate thickness provides sufficient protection against structural damage and operational loads, guaranteeing that the runway or other surfaces remain in optimal condition. In this way, the project not only meets technical and operational expectations but also supports thoughtful management of resources and sustainable results.

The following is a picture of the design of the thick re-layering of the flexible pavement of the runway at Toraja Airport. The image includes a longitudinal cutout and a runway cutout, which gives a clear idea of how the overlay will be applied to the runway, as well as how the load distribution will be managed after the re-layering is done.

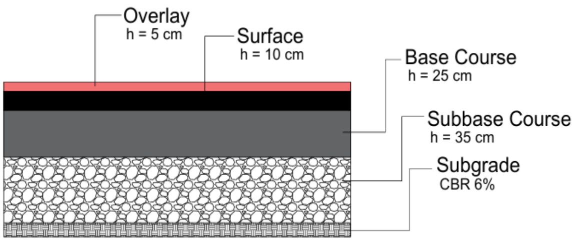

Figure 9 Visible Elongated Cut From Overlay Planning

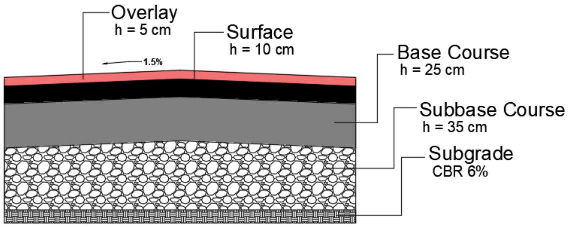

Figure 10 Horizontal Cut Seen as a Result of Overlay Planning

Draft Budget Cost Calculation

The calculation of the Draft Budget Cost in Overlay planning is a critical step that outlines the financial and material requirements necessary to execute the overlay on the planned runway. This comprehensive estimate includes various cost components such as the number of workers needed, the quantity and type of materials required, as well as the tools and equipment essential for the overlay process. Accurately estimating these factors ensures that the project is well-prepared and financially viable, minimizing the risk of cost overruns or material shortages during implementation.

The preparation of this Draft Budget Cost is carefully guided by the standard unit prices for wages, materials, and tools as set by Tana Toraja Regency in 2023. These standardized prices provide a reliable reference, ensuring that the cost estimates are aligned with current local economic conditions. For further transparency and accuracy, a detailed unit price analysis and volume analysis will be included in the attachment. This additional documentation offers a more in-depth breakdown of the cost components, allowing for a thorough review and ensuring that all aspects of the budget are meticulously accounted for, supporting effective project management and execution.

In the calculation of the Draft Budget Cost, it is very important to include the calculation of the volume of work as a first step. The volume of work includes an estimate of the quantity of materials, labor, and tools needed to carry out the project. By accurately calculating the volume of work, planners can determine the exact resource and cost requirements. This helps in ensuring that the budgets drawn up reflect the needs of the project realistically, as well as allowing for effective planning and cost management during the project execution phase. For the calculation of the volume of work, it includes:

1. Calculation of Measurement Work Area
2. Calculation of Pavement Patch Layer Dismantling Work Volume
3. Calculation of Tack Coating Work Area
4. Calculation of Concrete Asphalt Layer Work Volume

The following are the details of the Draft Budget Cost of the Toraja Airport runway overlay work.

Table 3 Draft Budget Cost

COST BUDGET PLAN

ACTIVITIES : OVERLAY WORK OF RUNWAY 04-22 AND PATCHING STA 0+400 - 0+500
LOCATION : TORAJA AIRPORT, TANA TORAJA REGENCY, SOUTH SULAWESI PROVINCE
F.Y. : 2024

NO	JOB DESCRIPTION/MATERIAL	UNIT	VOLUME	UNIT PRICE Rp.	TOTAL PRICE Rp.
A	PEKERJAAN PERSIAPAN				
1	Direksi keet	m2	30.00	Rp 1,980,837.00	Rp 59,425,110.00
2	Project signage	bh	1.00	Rp 1,254,011.00	Rp 1,254,011.00
3	Mobilization and demobilization	ls	1.00	Rp 87,000,000.00	Rp 87,000,000.00
4	Initial and final measurements	m2	120,000.00	Rp 5,201.20	Rp 624,143,865.60
B	PEKERJAAN PATCHING				
1	Dismantling of the patching pavement layer	m3	0.25	Rp 75,224.00	Rp 18,956.45
2	Tack coating (1.5 kg/m2) patching work	m2	5.04	Rp 31,235.72	Rp 157,428.03
3	5 cm thick concrete asphalt layer Patching	m2	0.58	Rp 263,806.23	Rp 152,902.09
C	PEKERJAAN PELAPISAN				
1	Tack Coating (1.5 kg/m2)	m2	60,000.00	Rp 31,235.72	Rp 1,874,143,200.00
2	Concrete asphalt layer 5 cm thick	m3	6,900.00	Rp 263,806.23	Rp 1,820,263,006.32
TOTAL					Rp 4,466,558,479.49
VAT 11%					Rp 491,321,432.74
TOTAL AMOUNT					Rp 4,957,879,912.23
TOTAL PRICE ROUNDED					Rp 4,957,900,000.00
Calculated : Four Billion Nine Hundred Fifty Seven Million Nine Hundred Thousand Rupiah					

After the preparation of the Draft Budget Cost, the preparation of the S-curve can be carried out. The estimated time for the resurfacing of the runway and patching of STA 0+400 – 0+500 Toraja Airport, is estimated to be 4 months of work. For the S-curve, the work time has been attached as follows.

Table 4 S-Curve

S-CURVE
OVERLAY WORK OF RUNWAY 04-22 AND PATCHING STA 0+400 - 0+500
TORAJA AIRPORT SOUTH SULAWESI F.Y. 2024

NO	WORK	JOB PRICING	WEIGHT	DURATION	PROCESSING TIME															
					MONTH-1				MONTH-2				MONTH-3				MONTH-4			
					1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1	Project signane	Rp 1,254,011.00	0.0281	1 Week	0.0281															
2	Direksi Keet	Rp 59,425,110.00	1.3304	1 Week	1.3304															
3	Initial measurements	Rp 312,071,932.80	6.9869	2 Week	3.4934	3.4934														
4	Mobilization	Rp 43,500,000.00	0.9739	2 Week			0.4870	0.4870												
5	Dismantling of the patching pavement layer	Rp 18,956.45	0.0004	1 Week					0.0004											
6	Tack coating (1.5 kg/m2) patching work	Rp 157,428.03	0.0035	1 Week					0.0035											
7	5 cm thick concrete asphalt layer Patching	Rp 152,902.09	0.0034	1 Week					0.0034											
8	Tack Coating (1.5 kg/m2)	Rp 1,874,143,200.00	41.9594	8 Week					5.2449	5.2449	5.2449	5.2449	5.2449	5.2449	5.2449	5.2449				
9	Concrete asphalt layer 5 cm thick	Rp 1,820,263,006.32	40.7531	8 Week					5.0941	5.0941	5.0941	5.0941	5.0941	5.0941	5.0941	5.0941				
10	Final measurements	Rp 312,071,932.80	6.9869	2 Week													3.4934	3.4934		
11	Demobilization	Rp 43,500,000.00	0.9739	2 Week															0.4870	0.4870
	TOTAL	Rp 4,466,558,479.49	100.00																	
	ACHIEVEMENT WEIGHT PLAN		100.00		4.85	3.49	0.49	0.49	10.35	10.34	10.34	10.34	10.34	10.34	10.34	10.34	3.49	3.49	0.49	0.49
	CUMULATIVE WEIGHT PLAN				4.85	8.35	8.83	9.32	19.67	30.00	40.34	50.68	61.02	71.36	81.70	92.04	95.53	99.03	99.51	100.00

CONCLUSION

Based on the results of the analysis and calculations that have been thoroughly conducted, several important conclusions can be drawn. These conclusions provide a comprehensive understanding of the data and insights obtained, which are crucial for making informed decisions and recommendations for the project.

1. Based on the comprehensive analysis of the type, area, and level of damage to the runway at Toraja Airport, it has been determined that the overlay planning needs to encompass the entire runway. The runway at Toraja Airport measures 2,000 meters in length and 30 meters in width, making it imperative that the overlay covers this full area to address all identified damage effectively. This approach ensures that both the extent and severity of the damage are fully managed, providing a uniform and durable surface that meets operational and safety standards. Consequently, the entire runway will be included in the overlay planning to enhance performance and longevity.
2. Based on the detailed analysis and calculations performed using FAARFIELD software, the results indicate that the minimum required thickness for the overlay is 50.8 mm. Additionally, the software has provided a Cumulative Damage Factor (CDF) value of 0.000. This extremely low CDF value suggests that the existing pavement structure is in excellent condition and has not experienced significant fatigue or deterioration. Given the CDF value, which reflects minimal wear and tear on the runway, the planned overlay thickness is set at 5 cm. This thickness is sufficient to maintain and enhance the performance of the runway while providing a robust and durable surface. The recommendation for a 5 cm overlay aligns with the need to ensure continued safety and operational efficiency without imposing unnecessary additional load or cost. The results underscore that the runway's current structural integrity is strong, allowing for a relatively thin overlay to achieve the desired improvements. By adopting this recommended overlay thickness, the maintenance strategy can be both cost-effective and efficient, ensuring the runway remains in optimal condition for future use.
3. Based on the Cost Budget Plan for the overlay work with a recommended thickness of 5 cm, the estimated total cost is Rp4,957,900,000.00 (four billion nine hundred and fifty-seven million nine hundred thousand rupiah). This comprehensive budget includes all necessary components for the successful implementation of the project. The cost estimate covers expenses such as materials, labor, equipment, and any additional operational costs required to complete the overlay. By detailing each aspect of the budget, this plan ensures that all financial requirements are accounted for, allowing for accurate financial planning and resource allocation. This thorough budgeting is essential for ensuring the project is executed efficiently and within the allocated financial constraints.

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