EVALUATION OF RUNWAY PAVEMENT CONDITION BASED ON CIVIL ENGINEERING TEST RESULTS AT AJI PANGERAN TUMENGGUNG PRANOTO AIRPORT, SAMARINDA

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ABSTRACT
Aji Pangeran Tumenggung Pranoto Airport is a class I airport located in Samarinda City, East Kalimantan Province. Damage to the runway pavement was found, including one wheel lock and rubber deposit, so it is necessary to assess the condition of the pavement using the Pavement Condition Index (PCI) method so that the level of damage can be determined. Evaluation is also carried out based on the results of the Heavy Weight Deflectometer (HWD) tooltest to determine the strength of the pavement structure. An assessment using the Pavement Condition Index (PCI) method was conducted to determine the surfacecondition of the runway pavement. Assessment with this method uses 23 sample points. The Heavy Weight Deflectometer(HWD) test produces deflection, modulus and Pavement Classification Number (PCN) values, which can then determinethe right solution to fix the existing problems on the runway at Aji Pangeran Tumenggung Pranoto Samarinda Airport.The Pavement Condition Index (PCI) test results found that the PCI value at STA 0+000 to STA 0+100 is 51% and STA 2+200 to STA 2+250 is 63% so patching is needed. For the test results of the Heavy Weight Deflectometer (HWD) tool, it is known that the Pavement Classification Number (PCN) value is 50 with the Aircraft Classification Number (ACN) value of the B737-900ER critical aircraft, which is 56. Based on the two test results, it is necessary to carry out maintenance in the form of resurfacing the 5 cm thick AC-WC layer for all STAs on the runway. The cost required is Rp10,216,440,000.00 (Ten Billion Two Hundred Sixteen Million Four Hundred Forty Thousand Rupiah) with a repair area of 506,250 m3.
Keywords: Runway, Pavement Condition Index (PCI), Heavy Weight Deflectometer (HWD), Pavement Classification Number (PCN), Aircraft Classification Number (ACN), Budget Draft.

1. INTRODUCTION

A.P.T. Pranoto Airport (IATA: AAP, ICAO: WALS), located in Samarinda, East Kalimantan, Indonesia, was officially inaugurated on May 24, 2018, with a formal opening by President Joko Widodo on October 25, 2018. This airport, named after the first Governor of East Kalimantan, Aji Pangeran Tumenggung Pranoto, was established to replace the outdated Temindung Airport, which was unable to expand due to its location in a densely populated area, thus posing increased safety risks. The new airport, situated on Jalan Poros Samarinda-Bontang in Sungai Siring, spans 300 hectares and required an investment of 1.5 billion IDR for land acquisition and development.

The runway of A.P.T. Pranoto Airport measures 2250 x 45 meters and adheres to ICAO standards with a Pavement Classification Number (PCN) of 50 F/C/X/T. Despite its modern facilities, observations during On-The-Job Training (OJT) from October 3, 2023, to February 23, 2024, identified several issues, including damage from single-wheel maneuvers, rubber deposits, and surface cracks. These conditions necessitate a detailed assessment using the Pavement Condition Index (PCI) and Heavy Weight Deflectometer (HWD) to evaluate the extent of the damage and determine appropriate maintenance strategies. (KP 94, Tahun 2015).

This study aims to analyze the runway's condition using PCI and HWD measurements to guide effective maintenance and ensure the runway's safety and operational efficiency. The PCI, as per ASTM D-5340 standards, provides a framework for evaluating pavement distress and formulating repair strategies, while the HWD measurements assess the runway's structural capacity and load-bearing performance. (KP 93, Tahun 2015)

2. LITERATURE REVIEW

2. 1 Airport

According to Annex 14 of the International Civil Aviation Organization (ICAO), an airport is defined as a specific area of land or water, including its associated buildings, installations, and equipment, utilized entirely or partially for the arrival, departure, and maneuvering of aircraft. An airport encompasses the infrastructure required for aircraft operations, including runways and taxiways.

In line with Government Regulation No. 70 of 2001, an airport is characterized as an airfield designated for aircraft landings and takeoffs, as well as passenger boarding and disembarkation or the handling of cargo and mail. This regulation emphasizes that airports must be equipped with appropriate aviation safety and security facilities.

2. 3 Airport Airside Facilities

According to SKEP/77/VI/2005, which specifies the Technical Requirements for the Operation of Airport Technical Facilities, airside areas of an airport are distinct from public zones. Therefore, access to these areas requires security screening and special authorization for all individuals, goods, and vehicles (SKEP 77, 2005).

1. Runway

The runway is a dedicated paved surface intended for aircraft takeoffs and landings. Its fundamental component is the pavement, which must be structurally adequate to support the loads of aircraft during landing and departure. Key elements of the runway include the runway shoulders, runway strip, blast pad, runway end safety area (RESA), stopway, and clearway.

2. Taxiway

Taxiways are essential airside facilities that provide connectivity between the runway and other airport areas. They enable aircraft to move between the runway and parking positions, and link various airside facilities, including taxiway lines, apron taxiways, and rapid exit taxiways.

3. Apron

The apron is an airside area designated for aircraft operations such as passenger boarding and disembarking, refueling, parking, and maintenance. This facility is crucial for managing aircraft activities on the ground efficiently.

2.4 Pavement

According to KP 94 of 2015, pavement is defined as a layered infrastructure designed to support varying load capacities. Pavement construction is engineered and maintained to bear the loads placed upon it, ensuring operational uniformity and safety in aviation activities. Pavements are classified into two categories:

1. Flexible Pavement

As outlined in KP 94 (2015), flexible pavement is characterized by its elastic properties and ability to deform under loading. This type of pavement transfers the applied loads from the surface through its layers to the underlying subgrade, which provides the necessary support. Rokhmawati et al. (2023) describe flexible pavement as consisting of a surface layer made of asphalt, which is a mixture of aggregate and asphalt binder. Additionally, it includes a base layer of high-quality aggregate, either with or without asphalt, and a subbase layer made of granular material without binder.

2. Rigid Pavement

According to KP 94 (2015), rigid pavement, or concrete pavement, is constructed using aggregate materials bound together with cement. Unlike flexible pavement, rigid pavement derives its load-bearing capacity from the concrete slab, which distributes loads over a broader area while reducing stress on the underlying layers. Rigid pavement differs from flexible pavement in that its strength is provided by the concrete slab, allowing for more effective load distribution with lower stress on the sublayers. Diagrams of both flexible and rigid pavement structures are provided for illustration.

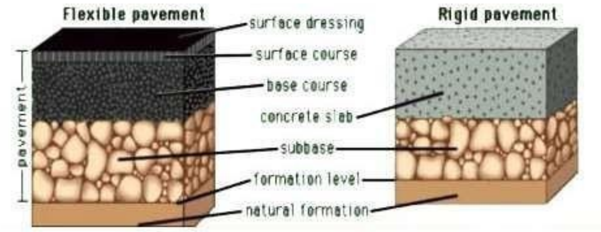


Figure 1 Lapis Perkerasan lentur dan Perkerasan kaku.

2.5 PCI Calculation

According to SKEP 77 (2005), the Pavement Condition Index (PCI) is a method for evaluating the extent of damage in a pavement, which allows for the determination of its surface condition. This index is applicable to both flexible and rigid pavements. The assessment involves a visual inspection or direct survey of the pavement, beginning with the measurement of predefined dimensions. The PCI is represented as a numerical value ranging from 0 to 100, with ratings classified as Failed, Very Poor, Poor, Fair, Good, Very Good, and Excellent.

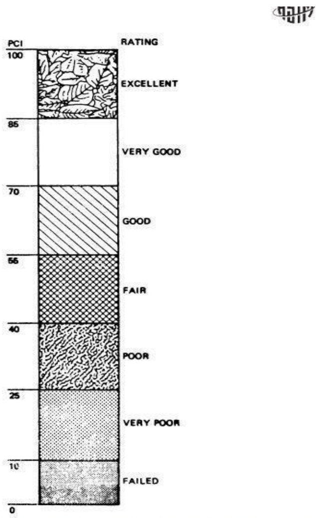


FIG. 1 Pavement Condition Index (PCI) and Rating Scale

Figure 2 Indeks Numerik PCI

1. Density

Density, or the extent of damage, is expressed as the percentage of a particular type of distress relative to a unit area of pavement, measured in square meters. This metric is differentiated based on the severity of the damage observed in the pavement. The formula used to determine the density value is as follows:

$$Density = \frac{Ad}{As} x100 \quad (1)$$

Or…

$$Density = \frac{Ld}{As} x100 \quad (2)$$

Definitions:

Ad: The total area affected by each type of distress at different levels of severity (m^2)

Ld: The cumulative length of each type of distress at specific points of damage (m)

As: The total area of the unit segment under consideration (m^2)

2. *Deduct Value* (DV)

Deduct Value represents the reduction assigned to each type of distress, calculated based on the density percentage and the associated deduct value. The curve for deduct value is illustrated below.

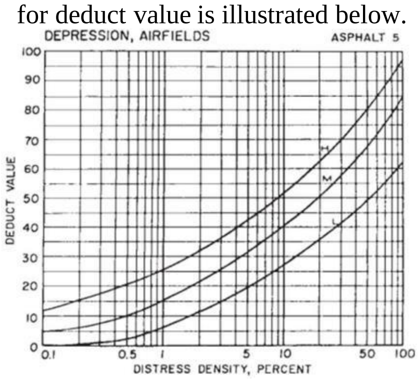


Figure 3 Grafik Depression

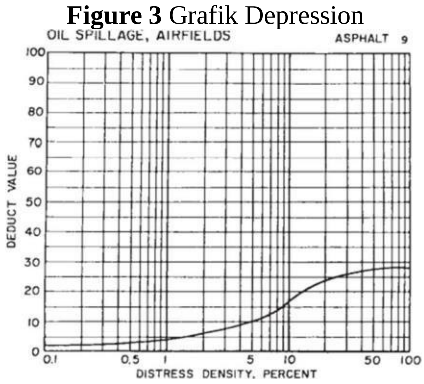


Figure 4 Grafik Depression

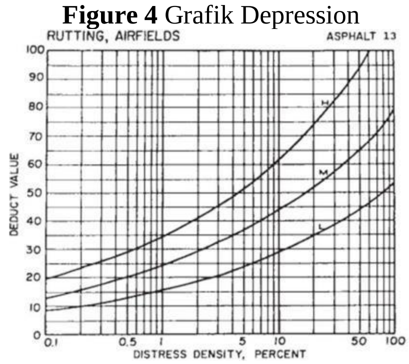


Figure 5 Grafik Rutting

3. Total Deduct Value *(TDV)*

The Total Deduct Value (TDV) is calculated based on the graph that depicts the correlation between Deduct Value (DV) and the density of each type of distress in the pavement.

4. *Correct Deduct Value (CDV)*

The Correct Deduct Value (CDV) is determined using the graph that illustrates the relationship between Total Deduct Value (TDV) and Deduct Value (DV). Values of DV greater than 2 are referred to as qqq. This qqq value is then correlated with the TDV to compute the Correct Deduct Value (CDV).

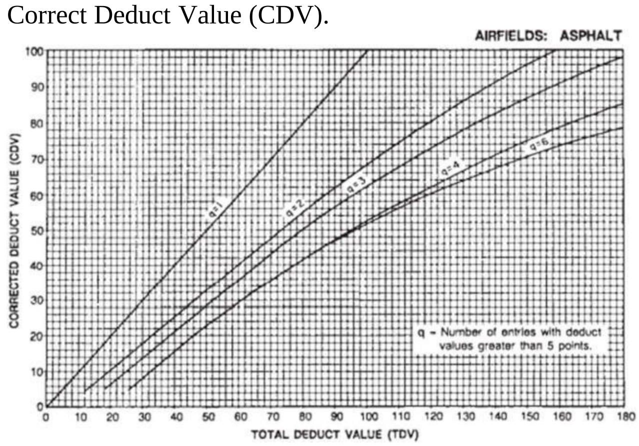


Figure 6 Grafik Total Deduct Value (TDV)

5. Pavement Condition Index (PCI)

The Pavement Condition Index (PCI) assesses the condition of a pavement surface through a numerical score ranging from 0 to 100, where higher scores reflect better pavement quality. This index is calculated based on a comprehensive evaluation of surface distresses and their severity, providing a standardized measure to gauge pavement performance and guide maintenance decisions. Once the Correct Deduct Value (CDV) has been determined, the Pavement Condition Index (PCI) for each segment can be calculated using the following formula:

$$PCI(s) = 100 - CDV \quad (1)$$

For the overall PCI value:

$$PCI = \frac{ZPCI(s)}{N} \quad (2)$$

Definitions:
PCI: The overall Pavement Condition Index value.
PCI(s): The PCI value for each individual segment.
N: The total number of segments.

The classification of pavement condition according to the PCI value can be referenced using the scale provided in the following figure:

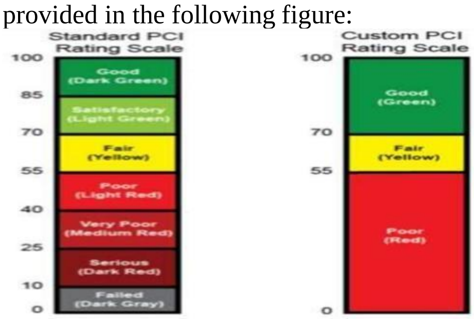


Figure 7 Diagram Nilai PCI

2.6 Types of Distress in Flexible Pavements

To assess damage in flexible pavements of runways, a detailed analysis is conducted to categorize the distress into appropriate severity levels, thereby guiding the selection of effective repair methods. According to KP 94 (2015) regarding Airport Pavement Maintenance Guidelines, common types of distress in flexible pavements include:

1. Potholes

2.8 Heavy Weight Deflectometer (HWD)

The Federal Aviation Administration (FAA) prescribes the use of the Heavy Weight Deflectometer (HWD) as a standard method for evaluating pavement performance. The HWD measures deflection to assess the uniformity of pavement load-bearing capacity.
According to KP 93 (2015), the HWD test involves applying a load to the pavement and recording deflections with geophones placed on the surface. The collected deflection data is analyzed using back-calculation methods through specialized software, which provides the modulus values for each pavement layer. The HWD test is conducted in two phases:

1. Initial Measurement

Potholes vary in size and form depressions that trap and retain water, which exacerbates the damage to the pavement structure.

2. Longitudinal and Transverse Cracking

Longitudinal and transverse cracking involves isolated or non-interconnected cracks that extend along the pavement surface, appearing either as individual fissures or aligned groups.

3. Raveling

Raveling occurs when water infiltration leads to the deterioration of the pavement surface, similar to the effects seen in potholes, causing the loss of aggregate and further pavement degradation.

4. Contamination from Oil, Grease, and Rubber Deposits

Contamination results from oil or grease spills and rubber deposits from aircraft tires, contributing to pavement wear and distress.

5. Localized Depression

Localized depressions are areas where the pavement surface subsides, potentially accompanied by cracks and observable water pooling, caused by factors such as excessive load, soil settlement, or poor construction practices.

6. Rutting

Rutting is characterized by the formation of grooves parallel to the direction of aircraft movement, leading to water accumulation and surface cracking due to the repeated passage of aircraft.

2.7 Damage Repair

According to KP 94 (2015) on Airport Pavement Maintenance, the repair methods for different levels of pavement distress are as follows:

1. Minor Distress

For small-scale damage in non-critical areas, routine cleaning and regular inspections are adequate.

2. Moderate to Severe Distress

For damage that is medium in scale, localized patching with hot mix asphalt, aligned with surface thickness specifications, is recommended.

3. Severe Distress

For extensive damage involving significant material loss and widespread issues, resurfacing or overlaying the pavement is advised.

The HWD records vertical deflections at seven test points on the pavement using geophone sensors. This data helps evaluate the pavement's load response.

2. Field Measurement

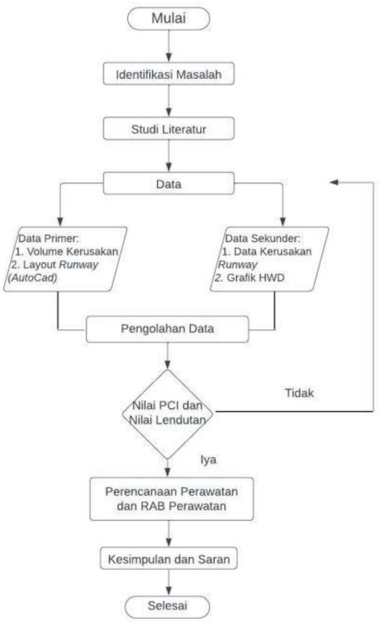
The test involves placing a load plate on the pavement surface and measuring the resulting deflections with sensors. The main objective is to correlate the applied load with the observed deflection.

Overall, the HWD test, supported by back-calculation and ELMOD software, determines the modulus of each pavement layer and calculates the Pavement Classification Number (PCN).

3.2 Bill of Quantities (BoQ)

The Bill of Quantities (BoQ) provides a cost estimate for each task within a project, prepared prior to project initiation. It involves calculating the volume of materials and equipment, and then determining the total

3. METHOD



3.1 Problem indentification

Analyze the issues addressed in the research. This study focuses on evaluating runway damage at A.P.T. Pranoto Samarinda Airport using the Pavement Condition Index (PCI) method to assess the extent of deterioration. Additionally, it examines deflection values obtained from Heavy Weight Deflectometer (HWD) testing. The combined results of these civil

using the Pavement Condition Index (PCI) methodology.

2. Runway Layout (AutoCAD)

This includes the runway's layout provided in AutoCAD format.

Figure 8 Layout Runway

B. Secondary Data

1. Runway Damage Documentation

This dataset includes records of runway surface damage used to calculate the Pavement Condition Index (PCI). Detailed damage information is provided in the appendices.

2. HWD Deflection Graphs

Graphs from Heavy Weight Deflectometer (HWD) tests are used to evaluate runway deflection. These graphs are available in the appendices.

3.5 Data Analysis Using the PCI Method

cost for materials and labor for each task. For accurate cost estimation, the BoQ relies on volume data to calculate the base costs. This study uses the 2024 Unit Prices for Materials and Labor in Samarinda City to develop the BoQ.

engineering assessments will be used to develop solutions for addressing runway damage at the airport.

3.3 Literatur Review

The literature review encompasses the process of gathering data from various sources, including books, documents, journals, and scientific articles, which inform the research. For this study, the relevant supporting documents include KP 94 of 2015, which provides guidelines for airport pavement maintenance programs; ASTM D-5340, detailing the standard test method for assessing the Airport Pavement Condition Index (PCI); and KP 93 of 2015, which outlines technical operational guidelines for civil aviation safety regulations, Section 139-24, as well as guidelines for calculating the Pavement Classification Number (PCN) for airport infrastructure.

3.4 Data Collection

This study on evaluating runway pavement conditions at A.P.T. Pranoto Samarinda Airport employs datafrom two key civil engineering assessments: the measurement of surface damage using the Pavement Condition Index (PCI) method and deflection values obtained via the Heavy Weight Deflectometer (HWD). The data are categorized into primary and secondary sources as follows:

A. Primary Data

1. Extent of Runway Damage

This involves conducting site surveys and measuring the extent of damage to assess the runway's condition Evaluating the condition of airport runway pavement is essential for determining effective repair strategies. The Pavement Condition Index (PCI) method is used to assess the severity of surface damage.

PCI values, which indicate the level of damage, are detailed in Table 1:

Table 1 *Nilai PCI*

NILAI PCI	KONDISI
0-10	Gagal (Failed)
11-25	Sangat Buruk (Very Poor)
26-40	Buruk (Poor)
41-55	Sedang (Fair)
56-70	Baik (Good)
71-85	Sangat Baik (Very Good)
86-100	Sempurna (Excellent)

The PCI method involves several steps for assessing runway pavement conditions, as detailed in ASTM D-

5340 (American Society for Testing and Materials, 2012):

1. Calculating Total Sample Units
To determine the number of sample units, divide the total survey area by the area of one sample unit, according to ASTM D-5340-12. For this study:

Total Runway Area:

$45 \text{ m} \times 2250 \text{ m} = 101{,}250 \text{ m}^2$ (1)

Area of One Sample Unit :

450 m² -180 m² (diambil 450 m²)

Total Sample Units:

Total Area / Area of One Sample Unit

= 101,250 m² / 450 m² (2)

= 225 samples

This calculation is crucial for establishing the minimum sample size needed for the survey.

2. Determining the Minimum Sample Size
To minimize the need for a comprehensive survey or full reporting of all sample units, the minimum sample size is calculated using Equation 2:1. This calculation follows the formula specified in ASTM D-5340.

$$n = \frac{Ns^2}{\frac{e^2}{4}(N-1)+s^2} \quad (1)$$

n = Minimum number of samples required for analysis
e = Acceptable margin of error in PCI calculations, which is ±5 PCI points
s = Standard deviation of PCI values between samples within a segment, with a value of 10 for AC pavements and 15 for PCC pavements
N = Total number of sample units available

$$n = \frac{225 \times 10^2}{\frac{5^2}{4}(225-1)+10^2} \quad (1)$$

$$n = \frac{22.500}{\frac{25}{4}(224)+100} \quad (2)$$

$$n = \frac{22.500}{1.500} \quad (3)$$

$$n = 15$$

Based on these calculations, the minimum number of samples required for the survey is 15. However, increasing the sample size to 23, with each unit measuring 100 × 45 m², is also acceptable as it allows for a more detailed evaluation of pavement damage.

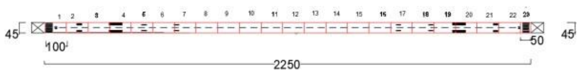


Figure 9 Layout Runway

3. Calculating Damage Density

After determining the minimum sample size, the next step is to compute the damage density. Density represents the percentage of the area affected by specific damage relative to the total area of the measurement segment, using the formula outlined in ASTM D-5340.

4. Calculating Deduct Value
Following the density calculations, the Deduct Value is determined. This value quantifies the reductionassociated with each type of damage based on density andseverity, and is plotted on a graph to assess the impact.
5. Calculating Total Deduct Value (TDV)

Total Deduct Value (TDV) is the sum of Deduct Values for each sample unit. The Deduct Values are ranked from highest to lowest to derive a value 'q,' which is used for plotting on the Corrected Deduct Value graph.

6. Calculating Corrected Deduct Value (CDV)
The Corrected Deduct Value (CDV) is obtained by plotting the TDV on a graph according to the value of 'q.' This involves using the 'q' value derived from Deduct Values and plotting it to determine the CDV for each sample unit.
7. Calculating PCI Value

The Pavement Condition Index (PCI) is calculated by subtracting the CDV from 100, using the formula: PCI = 100 - CDV.

3.6 Results of HWD Testing
The Heavy Weight Deflectometer (HWD) test measures pavement deflection and produces deflection bowl values. These values are recorded by geophones positioned at the center of the loaded area and at specified distances from the center. The deflection data obtained are used to evaluate the necessary thickness for additional overlay layers (Falling Weight Deflectometer (FWD) Testing Methods, 2019).

3.7 Maintenance and Repair Planning

To evaluate the civil engineering work on runway pavement and plan its maintenance and repair, technical guidelines will be followed. These include KP 94 of 2015, which outlines the guidelines for airport pavement maintenance programs; ASTM D-5340, which specifies the Standard Test Method for Airport Pavement Condition Index Survey; and KP 93 of 2015, which provides technical operational guidelines for civil aviation safety regulations, Section 139-24, and guidelines for calculating the Pavement Classification Number (PCN).

3.8 Damage Volume

Surveys conducted on the runway pavement at A.P.T. Pranoto Samarinda Airport help identify the types, dimensions, depth, and extent of damage. This information allows for the calculation of the total damage volume, which is essential for estimating the costs associated with maintenance and repair planning.

3.9 Budget Calculation

The volume of work required is used to estimate the budget for maintenance and repair based on the selected maintenance methods. The budget estimate is calculated using the Unit Price List for Labor and Construction Materials from the Government of Samarinda for the year 2024.

4. RESULT

4.1 Calculation of Pavement Condition Index (PCI)

Based on the data presented in section 3, the civil engineering analysis of the runway surface was conducted using the Pavement Condition Index (PCI) method. This analysis determined the condition of the runway based on its dimensions. At A.P.T. Pranoto Samarinda Airport, 23 samples, each with dimensions of 100 × 45 meters, were utilized for this assessment. The following are the PCI calculations for 23 samples:

NO	STA	CDV Max	NILAI PCI	Keterangan
1	0+000 - 0+100	49	51	Sedang
2	0+100 - 0+200	0	100	Sempurna
3	0+200 - 0+300	26	74	Sangat baik
4	0+300 - 0+400	26	74	Sangat baik
5	0+400 - 0+500	26	74	Sangat baik
6	0+500 - 0+600	26	75	Sangat baik
7	0+600 - 0+700	27	73	Sangat baik
8	0+700 - 0+800	27	73	Sangat baik
9	0+800 - 0+900	26	74	Sangat baik
10	0+900 - 1+000	19	81	Sangat baik
11	**1+000 - 1+100**	**0**	**100**	**Sempurna**
12	1+100 - 1+200	0	100	Sempurna
13	1+200 - 1+300	0	100	Sempurna
14	1+300 - 1+400	0	100	Sempurna
15	1+400 - 1+500	0	100	Sempurna
16	1+500 - 1+600	0	100	Sempurna
17	1+600 - 1+700	21	79	Sangat baik
18	1+700 - 1+800	26	74	Sangat baik
19	1+800 - 1+900	26	74	Sangat baik
20	1+900 - 2+000	21	79	Sangat baik
21	2+000 - 2+100	19	81	Sangat baik
22	2+100 - 2+200	0	100	Sempurna
23	2+200 - 2+250	37	63	Sedang
	Rata-rata		82	Sangat baik

The PCI calculations for the 23 samples resulted in an average value of 82. This score reflects a "very good" condition of the runway, indicating that the pavement is generally in excellent state with minimal deterioration.
The PCI calculations for the 23 samples resulted in an average value of 82. This score reflects a "very good" condition of the runway, indicating that the pavement is generally in excellent state with minimal deterioration.

4.2 Results of heavy weight deflectometer (hwd) testing

The pavement classification number (pcn) was calculated for the runway at a.p.t. pranoto samarinda airport following resurfacing work conducted in 2023. This assessment was carried out to evaluate the pavement condition through backcalculation methods. Two approaches were utilized to determine the pcn: the boeing method and a second method based on projected aircraft loads.

In addition to the pcn calculations, this report includes the aircraft classification number (acn) for typical aircraft based on the pavement type and subgrade conditions at a.p.t. pranoto airport. The acn values serve as a reference for determining the appropriate pcn required to support various aircraft types.

No.	Aircraft Type	MTOW (kg)	Gear Type*	Flexible pavements				Rigid pavements			
				ACN Subgrade kategori A	ACN Subgrade kategori B	ACN Subgrade kategori C	ACN Subgrade kategori D	ACN Subgrade kategori A	ACN Subgrade kategori B	ACN Subgrade kategori C	ACN Subgrade kategori D
1	Airbus A - 320	77,400	D	41	42	47	53	46	49	51	53
3	ATR 72	22,500	D	11	12	14	15	13	13	14	15
4	Boeing B - 737 series 300/400/500	63,000	D	33	35	39	43	38	40	42	43
5	Boeing B - 737 series 700/800/800NG	79,242	D	43	45	50	55	49	52	54	56
6	Boeing B - 737 series 900/900ER	85,366	D	48	51	56	61	56	58	61	63
7	CRJ-1000	38,329	D	20	21	24	26	23	24	25	26
8	Fokker F50	19,950	D	6	9	11	14	9	10	11	12

Figure 10 Nilai ACN yang dibutuhkan

4.3 Determination of PCN Value Using COMFAA

The Pavement Classification Number (PCN) for A.P.T. Pranoto Airport was determined utilizing the COMFAA method. This methodology involves evaluating the cumulative effect of all aircraft operations on the runway.

The diagram presented below depicts the results of the COMFAA analysis, illustrating the relationship between pavement thickness and aircraft load, with an example provided at a 95% confidence level.

TINGKAT KEYAKINAN (CONFIDENCE LEVEL)	METODE	
	Boeing/ Grafis	COMFAA
95%	PCN 42/F/C/X/T	PCN 41/F/C/X/T
90%*	**PCN 50/F/C/X/T**	**PCN 49/F/C/X/T**
85%	PCN 56/F/C/X/T	PCN 55/F/C/X/T
80%	PCN 56/F/C/X/T	PCN 56/F/C/X/T

Figure 10 Nilai ACN yang dibutuhkan

No.	Aircraft Type	MTOW (kg)	Gear Type*	ACN Subgrade kategori C
1	Airbus A - 320	77,400	D	47
4	Boeing B - 737 series 300/400/500	63,000	D	39
5	Boeing B - 737 series 700/800/800NG	79,242	D	50
6	Boeing B - 737 series 900/900ER	85,366	D	56

Airplanes can operate without restriction

restricted

Figure 11 Operasi Pesawat setelah ditetapkan PCN

Based on the COMFAA analysis, a Pavement Classification Number (PCN) of 50 was calculated. Given the Aircraft Classification Number (ACN) requirements for the Boeing B-737 series 900/900ER, it is recommended that a resurfacing or overlay be undertaken for the runway at A.P.T. Pranoto Airport.

4.4 Heavy Weight Deflectometer (HWD) Deflection Response

The Heavy Weight Deflectometer (HWD) testing conducted on the runway at A.P.T. Pranoto Airport, specifically between STA 1+800 and STA 2+250, showed relatively lower deflection responses compared to other locations along the runway.

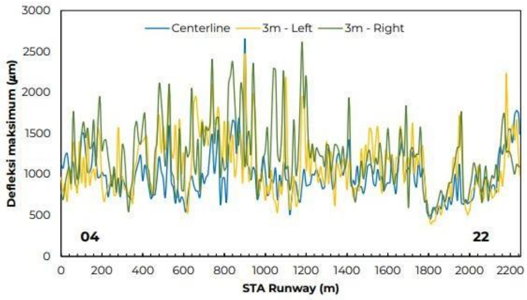


Figure 12 Respon Lendutan Heavy Weight Deflectometer (HWD)

4.5 Layer moduli from backcalculation results

The distribution of layer moduli for the different pavement layers of the runway is presented in the subsequent figures:

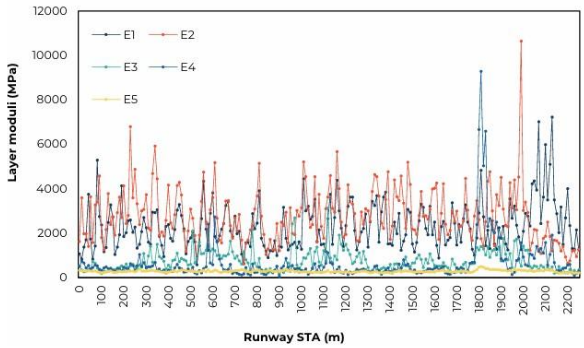


Figure 13 Distribusi nilai layer moduli E1 hingga E5 untuk Runway (Centerline)

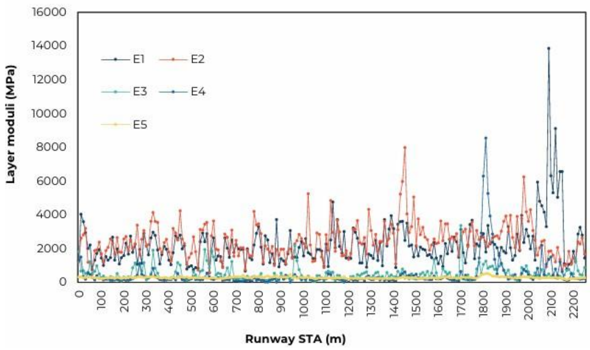


Figure 14 Distribusi nilai layer moduli E1 hingga E5 untuk Runway (3m Right)

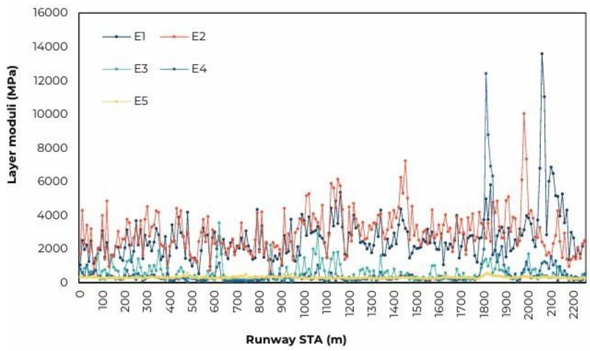


Figure 14 Distribusi nilai layer moduli E1 hingga E5 untuk Runway (3m Right)

Legend:
E1: hma surface ac-bc 1
E2: hma surface ac-bc 2
E3: ctb
E4: sub-base course
E5: subgrade
Summary of pavement condition index (pci) calculations and heavy weight deflectometer (hwd) test results. The pavement condition index (pci) assessments yielded values of 51% for sta 0+000-0+100 and 63% for sta 2+200-2+250, reflecting a moderate condition as per the

guidelines established in peraturan dirjen perhubungan udara kp 94, 2015, concerning airport pavement maintenance programs. These sections are recommended for patching. Additionally, the heavy weight deflectometer (hwd) testing indicated a pcn of 50, which is inadequate to support the maximum load of the b737-900er, which has an aircraft classification number (acn) of 56. Therefore, the hwd results suggest that a 5 cm overlay of ac-wc is necessary to meet the required load-bearing capacity.

4.6 Pavement structure

Post-milling, the runway pavement structure at a.p.t. pranoto airport is comprised of a 9 cm hma surface ac-bc layer, a 25 cm cement treated base (ctb) layer, and a 40 cm sub-base course layer, as shown in figure 4.39. Following the milling process, which removed a 12 cm thick asphalt layer, the thickness of the surface layer was reduced from 21 cm to 9 cm.

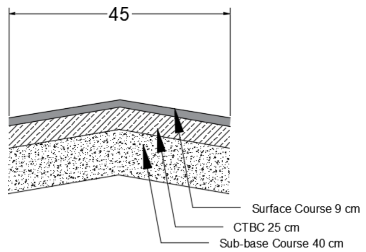


Figure 15 Struktur Lapis Perkerasan Eksisting

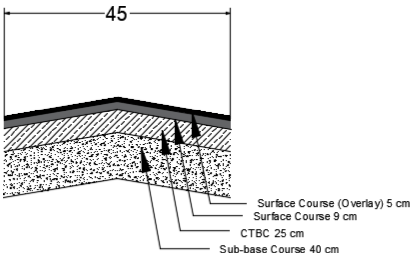
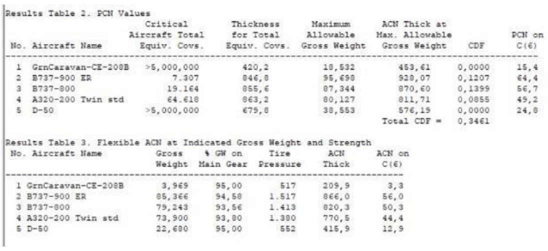


Figure 16 Struktur Lapis Perkerasan Rencana Overlay 5 cm

4.7 Recommendations

Based on the Heavy Weight Deflectometer (HWD) results, which recommend a 5 cm overlay, the proposed pavement structure for the runway at A.P.T. Pranoto Samarinda includes a 17 cm layer of HMA Surface AC-BC, a 25 cm layer of Cement Treated Base (CTB), and a 40 cm layer of Sub-base Course. This proposed structure will be further assessed using the COMFAA application to determine the Pavement Classification Number (PCN) and evaluate the strength of the pavement after the overlay is applied.



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(6)
1	GrnCaravan-CE-208B	>5,000,000	420,2	18,532	453,61	0,0000	15,4
2	B737-900 ER	7.307	846,8	95,698	928,07	0,1207	64,4
3	B737-800	19.164	855,6	87,344	870,60	0,1399	56,7
4	A320-200 Twin std	64.618	863,2	80,127	811,71	0,0855	49,2
5	D-50	>5,000,000	679,8	38,553	576,19	0,0000	24,8
					Total CDF =	0,3461	

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

No.	Aircraft Name	Gross Weight	% GW on Main Gear	Tire Pressure	ACN Thick	ACN on C(6)
1	GrnCaravan-CE-208B	3,969	95,00	517	209,9	3,3
2	B737-900 ER	85,366	94,58	1.517	866,0	56,0
3	B737-800	79,243	93,56	1.413	820,3	50,3
4	A320-200 Twin std	73,900	93,80	1.380	770,5	44,4
5	D-50	22,680	95,00	552	415,9	12,9

Figure 17 *Hasil Uji COMFAA*

4.8 Cost Estimation

The cost estimation (RAB) for the proposed overlay involves assessing the required materials and financial resources, including labor, materials, supplies, and equipment needed for the runway resurfacing. This estimate is developed according to the Standard Unit Prices established by the Government of Samarinda City for the year 2024.

RENCANA ANGGARAN BIAYA

KEGIATAN :PEKERJAAN PELAPISAN ULANG (OVERLAY) LANDAS PACU

LOKASI :BANDAR UDARA AJI PANGERAN TUMENGGUNG PRANOTO SAMARINDA

NO	URAIAN PEKERJAAN/MATERIAL	SATUAN	VOLUME	HARGA SATUAN Rp.	JUMLAH HARGA Rp.
A	**PEKERJAAN PERSIAPAN**				
1	Direksi keet	ls	30,00	Rp 205.228,76	Rp 6.156.862,80
2	Mobilisasi dan demobilisasi	ls	1,00	Rp 30.000.000,00	Rp 30.000.000,00
3	Pembersihan	ls	2,00	Rp 241.875,00	Rp 483.750,00
4	Pengukuran	m2	101.250	Rp 14.248,16	Rp 1.442.625.795,00
B	**PEKERJAAN PELAPISAN**				

1	Pekerjaan Tack Coating (1.5 kg/m2)	m2	101. 250	Rp 58.435, 66	Rp 5.916.61 0.473,75
2	Lapisan aspal beton tebal 5 cm	m3	5.06 3	Rp 357.055 ,78	Rp 1.807.59 4.893,84
Jumlah	**Rp 9.203.471.775,39**				
Dibulatkan	**Rp 9.204.000.000,00**				
PPN 11%	**Rp 1.012.440.000,00**				
Jumlah Total	**Rp 10.216.440.000,00**				
Terbilang : Sepuluh Miliar Dua Ratus Enam Belas Juta Empat Ratus Empat Puluh Ribu Rupiah					

5. CONCLUSION

1. The average Pavement Condition Index (PCI) across the runway was 82%, signifying an overall excellent condition. However, sections STA 0+000-0+100 and STA 2+200-2+250 were categorized as having a moderate PCI of 51% to 63%, requiring patching repairs.
2. Heavy Weight Deflectometer (HWD) testing indicated a reduction in the Pavement Classification Number (PCN) from 59 to 50, whereas the Aircraft Classification Number (ACN) for the critical B737-900ER is 56.
3. Given these findings, it is recommended to perform a 5 cm overlay with AC-WC on the runway at A.P.T. Pranoto Airport. This overlay is projected to increase the PCN to 64.4, which should support the operation of the B737-900ER.
4. The estimated cost for this runway overlay is Rp 10,216,440,000.00 (Ten Billion Two Hundred Sixteen Million Four Hundred Forty Thousand Rupiah).

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