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INCREASEMENT OF PCN VALUE DESIGN FOR AIRBUS A330-300: RUNWAY PAVEMENT FORECASTING

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Abstract
The Airbus A330-300 has a maximum ACN value of 81, higher than the existing Komodo Airport runway PCN value of 55, so the PCN ≥ ACN value requirement is not fulfilled. Komodo Airport, as its aviation infrastructure, has the responsibility to provide safe aviation facilities, such as the availability of a runway to serve the largest planned aircraft. This study aimed to calculate the requirements of pavement thickness and PCN values that were carried out by using the FAARFIELD and COMFAA programs. Methods used in this study are quantitative research, in which observation and unstructured interviews are used as primary data, and previous related study data are used as secondary data. The result showed that there was the addition of a surface layer thickness of 15.3 cm in the first segment, 8 cm in the second segment, 5.1 cm in the third and fourth segments, and an increase in the PCN value from 55 F/C/X/T to 80 F/C/X/T. In conclusion, these results make the Komodo Airport runway capable of accommodating the type of Airbus A330-300 around the year 2035.
Keywords: *FAARFIELD, COMFAA, Pavement thickness, PCN value*

Introduction

As one of the largest archipelagic countries, Indonesia has abundant and diverse tourist destinations, which undoubtedly contribute to the economy. In the tourism sector itself, Indonesia still relies on Bali with a percentage of 41%, so the government has developed a program to amplify tourist destinations outside Bali that can provide economic benefits for local communities and Bali. Based on Presidential Regulation of Republic Indonesia Number 18 of 2020, the program is contained in a strategic priority project named 10 Destinasi Pariwisata Prioritas (DPP) concerning Indonesia's National Medium-Term Development Plan (RPJMN) 2020-2024. Ten of them are Labuan Bajo in East Nusa Tenggara. To support the 10 DPP program, Komodo Airport, one of the vital physical facilities in air transportation, must keep pace with predicted future conditions and increase the number of air transportation users by upgrading its infrastructure to accommodate larger aircraft.

Gitosudarmo and Mulyono in 2012 stated that forecasting is an effort made to be able to predict future conditions by using historical data that has been owned to be projected into a model and using the model to predict future conditions (Al-Barrah et al., 2020). Forecasts are unlikely to be able to predict the future very precisely because data inaccuracies will always occur in the results obtained in forecasts. Even so, forecasts are still needed to provide an overview of the level of service of an airport and the provision of its facilities (Saelendra et al., 2022).

According to International Air Transport Association (IATA), forecasting methods with econometric models for air transportation demand can be explained through several explanatory variables such as ticket prices, GRDP, population, and money exchange rates (Persadanta, 2021). International Air Transport Association (IATA) views that econometric-based forecasting methods are considered the most effective in use for airport planning with adjustments to airline strategies, transparent assumptions, and comprehensive reviews of matters that can affect planning in the long term (Rollando et al., 2022).

One of the pivotal infrastructures to support the operation of airports is the runway, one of the airside facilities in the form of a square patch of land that is prepared for airplanes to take off and land safely in various conditions. The runway can be a grass field whose length depends on the type of critical airplane operating, the height of the airport to sea level, the airport's temperature, and the runway's slope (Gunawan, 2019).

Flexible pavement is used in runway facilities at Komodo Airport, where flexible pavement is a pavement that is often used for runway planning in Indonesia because the time required for repairs is faster than rigid pavement. The flexible pavement structure consists of surface course, base course, sub-base course, and subgrade (Prayoga et al., 2018). In line with Prayoga et al., (2019) a flexible pavement structure is composed of various layers which are bituminous surfacing (surface course), road base (base course), and subbase (Mashaan et al., 2014).

ICAO developed a system in 1977 to control the load of aircraft operating on the pavement construction of airside facilities at an airport with an all-up mass of 5,700 kg termed the ACN-PCN system. Aircraft Classification Number (ACN) can be defined as a value that indicates the effect of an aircraft on a different pavement with the numbering varying according to the strength of the subgrade, the type of pavement, and the aircraft and its configuration. On the other hand, Pavement Classification Number (PCN) is a value that describes the bearing capacity of a pavement without specifying a particular type of aircraft expressed by varying numbering (Pradana et al., 2020). The existing condition of runway pavement strength at Komodo Airport is 55 F/C/X/T with Airbus A320 as the most critical aircraft which has an ACN of 47. This value is smaller if compared to the ACN value of the planned aircraft, namely Airbus A330-300 of 81 so the requirement of PCN ≥ ACN value is not met the requirement itself.

Federal Aviation Administration (FAA), developed software for planning new pavements and overlays on flexible and rigid pavements called FAARFIELD and software for calculating ACN and PCN values using procedures and provisions set by ICAO known as COMFAA. FAARFIELD is a software developed by the FAA related to pavement thickness (Febrilian et al., 2020). In flexible pavement planning, FAARFIELD uses the maximum stress above the subgrade and the maximum horizontal stress below the entire asphalt layer as a predictor of pavement structure life. Meanwhile, COMFAA is a software used to analyze the strength of airport flexible pavement with existing pavement thickness data. Some input data needed so that the COMFAA program can be run with the aim of calculating PCN values include aircraft traffic data, design pavement thickness, and existing PCN values (Rahmawati et al., 2022).

In order to obtain a solution to the problem, previous research is used to find out the research methods carried out and the research results achieved as a comparison material as well as a benchmark for the research being carried out. A study recommends thickening the runway surface at Banyuwangi Airport with Asphalt Concrete by 7.5 cm so that B737-900ER aircraft can operate. The analysis carried out in the study was assisted by using the COMFAA program (Nugroho et al., 2021). Another study, using the help of the FAARFIELD and COMFAA programs, resulted in recommendations to increase the layer thickness of the existing runway pavement by 2 inches or 5 cm which increased the runway PCN value to 88 F/A/X/T, so that the B777-300ER critical plan aircraft can be accommodated by the Lombok International Airport runway with maximum capacity (Sumarda et al., 2022).

Based on the review of previous research above, as one of the airport facilities whose role is fundamental in airport operations, the runway system must be properly designed in order to accommodate the growth and increase in air traffic volume (Paramahamsa et al., 2022). Further, the number of increasing aircraft movements is the most significant factors that affects as a consideration for airport expansion (Sampurno et al., 2018).

This study aimed to determine the PCN value of the runway needed in Komodo Airport in order to accommodate Airbus A330-300 as the largest aircraft plan contained in the airport master plan. In line with previous researcher, FAARFIELD and COMFAA was carried out as pavement thickness and PCN values recommendation in different type of aircraft. While difference between this study and previous study was the recommendation of thickness pavement for aircraft. In this study, researcher using FAARFIELD and COMFAA as a recommendation increasing thickness of pavement and PCN Value to accommodate for Airbus A330-300, while others for B737-900ER and B777-300ER.

Methods

The method used in this research is quantitative. Quantitative research defines as a research approach that emphasizes the collection, analysis and interpretation of data in numerical form (Creswell, 2013). Further, quantitative research is research method that dealing with numbers and anything that are measurable in a systematic way of investigation of phenomena and their relationships (Mohajan, 2020).

In this study, observation and unstructured interview was used to collect the primer data and previous related study data as a secondary data. Literature review, in which several research journals and related regulations that are closely relevant to the research topic were used, and direct observation and unstructured interviews during research visits were some of the collection techniques applied.

The data analysis method utilized in this research includes four stages starting with the analysis of runway dimension requirements, then forecasting to determine future passenger movements with econometric analysis, then analyzing the required pavement thickness with the FAARFIELD program, and analyzing the PCN value with the COMFAA program. The scope of the analysis is limited by only discussing the runway pavement layer with the assumption of using flexible pavement, the analysis of pavement thickness calculation is only done using the FAARFIELD program, and the analysis of PCN value calculation is only done using the COMFAA program.

Results And Discussions

Econometric analysis is used in the calculation of forecasts of passenger growth in 2025 - 2035 with variables of annual passenger numbers, GRDP per capita, and dummies. A dummy was used in the calculation because there was a decrease in the number of passengers in 2015 due to the construction of a new terminal that had an impact on airport operations. On the other hand, the decline in the number of passengers that occurred in 2020 and 2021 was due to the Covid-19 pandemic. The calculation of passenger movement forecasts in the plan year can be done with data and variables as in Table 1 below.

Table 1. Calculation of Passenger Movement Forecast

Year	Number of Pax Movement (Y)	Per Capita GNP (X1)	*Dummy* (X2)
2011	112.220	6.773.274	0
2012	102.250	6.901.018	0
2013	165.504	7.011.356	0
2014	220.878	7.120.641	0
2015	166.888	7.294.912	1
2016	365.189	7.474.863	0
2017	456.249	7.688.835	0
2018	590.189	7.915.554	0
2019	694.015	8.181.770	0
2020	331.167	8.086.874	1
2021	363.865	8.113.787	1
2022	596.903	8.312.560	0

Based on the table above, regression calculations were carried out with Microsoft Excel and the econometric equation was obtained which can be written as,

Y = -2,382,214.752 + 0.367221x1 + (-206,504.263)x2.

Where Y is the number of passengers in the plan year, x1 is is GDP per capita, and x2 is a dummy. Based on (Akyüz, 2017) Indonesia's GDP growth rate for low, moderate, and high schemes is 4.3%, 5.3%, and

6.3% and from the above equation results can be obtained as in Table 2 below.

Table 2. Passenger Movement 2025-2045

Year	Passenger Movement		
	Low	Moderates	High
2023	801.595	832.120	862.646
2024	938.499	1.002.480	1.067.072
2025	1.081.289	1.181.869	1.284.377
2026	1.230.220	1.370.765	1.515.372
2027	1.385.555	1.569.673	1.760.920
2028	1.547.569	1.779.123	2.021.938
2029	1.716.549	1.999.674	2.299.399
2030	1.892.796	2.231.914	2.594.341
2031	2.076.622	2.476.463	2.907.864
2032	2.268.352	2.733.973	3.241.139
2033	2.468.326	3.005.131	3.595.410
2034	2.676.899	3.290.660	3.972.001
2035	2.894.441	3.591.323	4.372.316

Daily Aircraft Movement

Daily aircraft movement data is required for input to the FAARFIELD and COMFAA programs. To be able to calculate daily aircraft movements, Load Factor data is required. Based on data obtained from the Ministry of Transportation of the Republic of Indonesia, the load factor pattern at Komodo Airport fluctuates at 60% - 70% which is not too significant. Therefore, a load factor of 70% is assumed. The equation used to calculate daily aircraft movements is as follows and the calculation results are listed in Table 3. The traffic plan is obtained from the results of assumptions reinforced by statistical data on Komodo Airport domestic routes obtained from the Ministry of Transportation of the Republic of Indonesia. The traffic mix used is based on aircraft operating at Komodo Airport, excluding CRJ-1000 aircraft because based on unstructured interviews conducted, information was obtained that the aircraft had stopped operating at Komodo Airport.

Table 3. Daily Aircraft Movement

Year	Pax Movement	Aircraft Type	Seat Capacity	L/F	Traffic Plan	Daily Movement
2025	1.181.869	ATR72	70	0,07	0,2	13
		A320	180		0,3	8
		B737-800	184		0,3	8
		B737-900ER	215		0,2	5
2030	2.231.914	ATR72	70	0,07	0,1	13
		A320	180		0,3	15
		B737-800	184		0,3	15
		B737-900ER	215		0,3	13
2035	3.591.323	ATR72	70	0,07	0,1	21
		A320	180		0,3	24
		B737-800	184		0,2	16
		B737-900ER	215		0,2	14
		A330-300	300		0,2	10

Annual Departure can be obtained by multiplying the daily movement of aircraft by 365 and then dividing by two because it is assumed that the movement of departing aircraft is the same as arriving aircraft. The calculation results can be seen in Table 4.

Table 4. Annual Departure in 2035

Operating Aircraft	Annual Aircraft Movements	Annual Departure
ATR72	7.665	3.833
Airbus A320	8.760	4.380
Boeing B737-800	5.840	2.920
Boeing B737-900ER	5.110	2.555
Airbus A330-300	3.650	1.825

Pavement Thickness Requirement

The calculation with the FAARFIELD program begins with entering data on the thickness of the existing pavement layer that divided the runway into four segments.

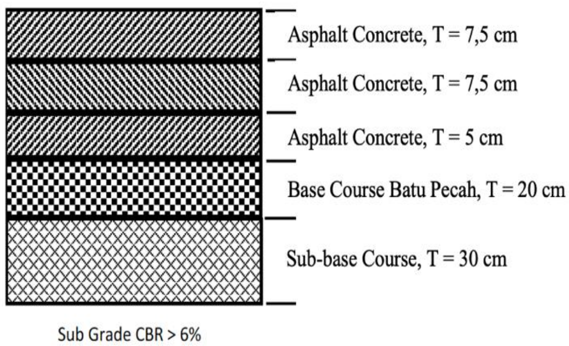

Figure 1. Layer Details of Existing Runway Pavement Segment 1

The results of running the FAARFIELD program on segment 1 obtained an additional thickness of the surface course of 153 mm or 15.3 cm. On the other hand, the CDF curve results show that the critical location is at a distance of 2.5 m - 5 m from the runway centerline. While the subgrade CDF value of I indicates that the pavement structure will spend its entire fatigue life of 20 years.

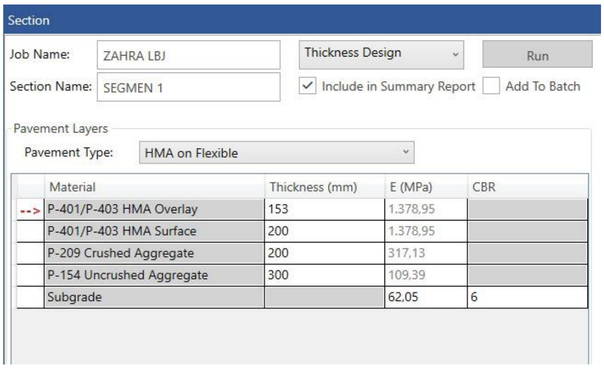

Figure 2. Results of Running the FAARFIELD Program on Segment 1

The same calculation was performed to the other three segments, resulting in the total pavement thickness shown in Table 5 below.

Table 5. Total Pavement Thickness of Runway

Segment	Total Pavement Thickness (mm)
STA 0+000 – STA 1+850	853
STA 1+850 – STA 2+250	930
STA 2+250 – STA 2+484	951
STA 2+484 – STA 2+650	1.101

PCN Value Calculation

Before performing calculations with the COMFAA program, there are additional tools in the form of Microsoft Excel Spreadsheet for determining the thickness of the evaluation. The standard/reference thickness used is 5 inches or 127 mm for P-401 and 8 inches or 203.2 mm for P-209 due to the number of wheels on the A330-300 aircraft main gear is more than four.

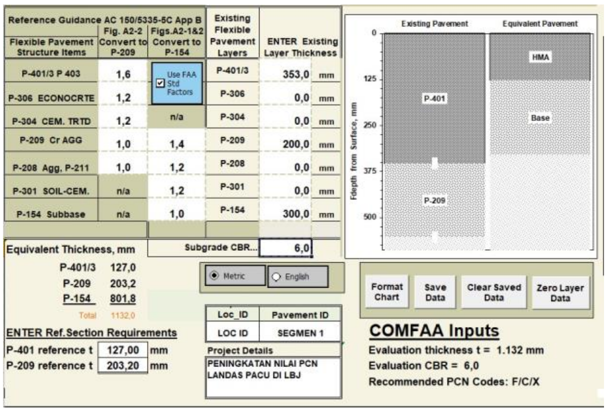

Figure 4. Equivalent Thickness Results for Segment 1

The thickness of the evaluation is used as input in the COMFAA program, so that from the calculation results the following runway pavement durability values can be obtained.

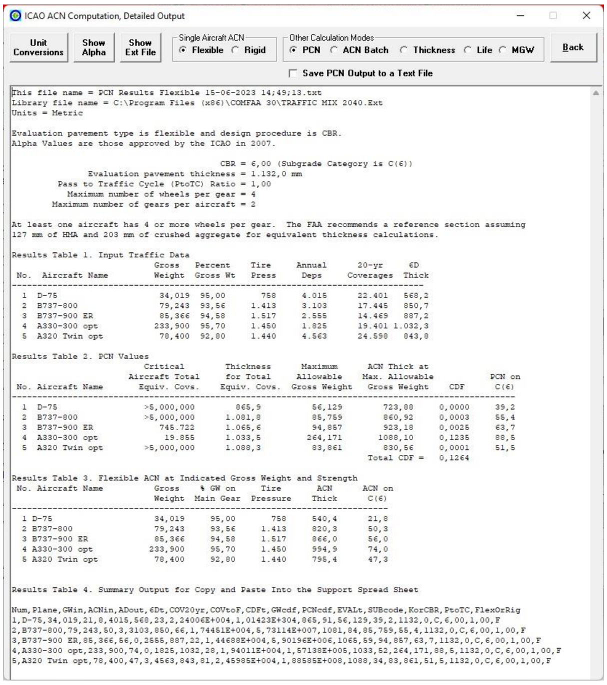

Figure 5. Results of COMFAA Program on Segment 1

Table 1 of the running results of the COMFAA segment 1 program shows the 6D Thick value of each operating aircraft is less than the thickness of the pavement evaluation in segment 1. This means that the thickness of the flexible pavement is in good condition or well designed.

Table 2 of the running results of the COMFAA program segment I shows the PCN value of each operating aircraft. The additional thickness of the surface layer of 15.3 cm has an effect on increasing the PCN value to 88 F/C/X/T in segment 1.

Table 3 of the running results of the COMFAA segment 1 program shows the ACN value of each operating aircraft. It can be seen that the ACN value of the plan aircraft A330-300 of 74 which means that the requirement of PCN ≥ ACN value is met. Next, the same steps were taken to calculate the PC values for the other three segments and the results are shown in Table 6 below.

Table 6. Komodo Airport Runway PCN Value to Accommodate Airbus A330-300

Segment	PCN Value
STA 0+000 – STA 1+850	88 F/C/X/T
STA 1+850 – STA 2+250	80 F/C/X/T
STA 2+250 – STA 2+484	88 F/C/X/T
STA 2+484 – STA 2+650	108 F/C/X/T

Conclusion

The construction or development of airports as a form of implementation of airport master plans carried out in stages is based on forecasts of increasing demand for air transportation traffic. Therefore, the pavement strength of airport airside facilities must be analyzed regularly to be able to support the planned aircraft. Airport airside facilities are designed based on the planned aircraft that has the largest aircraft load determined from the load of one main landing gear. From the calculation results, it is predicted that A330-300 aircraft will start operating at Komodo Airport around 2035 with annual passenger movements reaching 3,591,323 passengers. This figure is consistent with the ultimate stage in the Komodo Airport Master Plan. With the additional thickness of the surface layer of 15.3 cm in the first segment, 8 cm in the second segment, and 5.1 cm in the third and fourth segments, this is directly proportional to the increase in the PCN value of the existing Komodo Airport runway, which was originally 55 F/C/X/T increasing to 80 F/C/X/T which makes the Komodo Airport runway capable of serving the A330-300 aircraft plan with a maximum capacity that has a minimum ACN value of 34 and a maximum ACN of 81.

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