Eduvest – Journal of Universal Studies
Volume 3 Number 1, January, 2023
p- ISSN 2775-3735- e-ISSN 2775-3727

# EVALUATION OF THE DIMENSIONS AND THICKNESS OF THE ADI SOEMARMO SURAKARTA AIRPORT APRON PAVEMENT USING THE FAA (FEDERAL AVIATION ADMINISTRATION) METHOD

**Andika, Latif Budi Suparma, Suryo Hapsoro Tri Utomo**
Universitas Gadjah Mada, Indonesia
Email: andika.and3099@gmail.ugm.ac.id, latifbudisuparma@ugm.ac.id, suryohapsoro@ugm.ac.id

**ABSTRACT**

*Air transportation is the most recent mode of transportation among other modes and only emerged and developed in the 20th century. World Wars I and II gave a great impetus to the development of air transport in almost every country in the world. To make it easier to conduct this research, it is necessary to collect data related to "Evaluation of the Dimensions and Thickness of the Adi Soemarmo Surakarta Airport Apron Pavement Using the FAA (Federal Aviation Administration) Method". Data on air traffic movements is needed in performing the role or designing the pavement thickness of airport airside facilities. Data on aircraft movements is needed in forecasting the growth rate of aircraft at airports. It takes at least 10 years or at least the last 5 years to forecast the movement of the aircraft. The results of the calculation of apron dimensions were obtained by 560 m × 135 m while the dimensional conditions of the existing apron were 420 m × 135 m. Based on the results of these calculations, it is necessary to increase the apron length by 140 m, while for the width of the apron there is no need to widen so that the apron is able to serve aircraft traffic optimally for the next 20 years at Adi Soemarmo Surakarta Airport*

**KEYWORDS** *FAA; dimensions; thickness*



## INTRODUCTION

Air transportation is the most recent mode of transportation among other modes and only emerged and developed in the 20th century (Wicaksono, 2018). World Wars I and II gave a great impetus to the development of air transport in

| | |
|---|---|
| **How to cite:** | Andika, Latif Budi Suparma, Suryo Hapsoro Tri Utomo (2023). Evaluation of The Dimensions and Thickness of The Adi Soemarmo Surakarta Airport Apron Pavement Using The FAA (Federal Aviation Administration) Method. Journal Eduvest. *3* (1): 34-49 |
| **E-ISSN:** | 2775-3727 |
| **Published by:** | https://greenpublisher.id/ |

almost every country in the world (Sartono et al., 2015). Air transportation has a dual function, namely as a supporting element (*Service* sector) and a driving element (*promoting sector*) (Sartono et al., 2015). The role of transportation as a supporting element can be seen from its ability to provide effective and efficient transportation services to meet the needs of other sectors, as well as playing a role in driving development dynamics. As a driving element, air transportation has also proven to be an effective transportation service to open isolated areas and also serve remote areas and islands (Razi & Sumberdaya, 2014).

Surakarta City is one of the cities that has the largest airport in Central Java, namely Adi Soemarmo International Airport (Sefaji et al., 2018). Adi Soemarmo Airport has a *runway* length of 2.5 00 m x 45 m, *an Apron* area of 420 m x 135 m, and *a parking stand* that can accommodate 10 aircraft. The terminal area is 13,000 m 2 with a capacity of 1,525,013 passengers per year, and the car park is 29,000 m 2 which can accommodate 330 vehicles and the largest operating aircraft is the Airbus 330 which requires a runway length for *take off* of 2. 300 m and for *landing* by 1. 800 m with a passenger capacity of 295 passengers (Suryanto et al., 2021). The demand for air travel that increases every year is also expected to be in line with the performance of the Airport Airside facility so that it can serve the increase in demand that occurs, especially on the *Apron* (Setyaningsih, 2010).

*An apron* is a specific area on the surface of the airport (*aerodrome*) that aims to accommodate aircraft to raise and drop off passengers, goods or cargo, refueling, parking and aircraft maintenance. *The apron* is the part of the airport that serves the terminal so it must be designed according to the needs and characteristics of the terminal (Sartono et al., 2015).

The pavement structure as well as the dimensions of the *Apron* itself must be able to carry and receive loads from a number of aircraft on it and accommodate existing aircraft so that it can serve aircraft traffic properly. Pavement planning which is the main structure in *Apron* construction by itself is required to be able to accept and carry the load of traffic aircraft on it that is planned appropriately (Huzeirien & Dahlan, 2018). *The apron* was designed using rigid pavement because the *Apron* bore a fairly long static load and the place to refuel the aircraft.

This research is intended to evaluate the dimensions and pavement of the Adi Soemarmo Surakarta Airport Apron and obtain the results of the calculation of the construction of the Apron pavement and the planned *Apron* dimensions with a carrying capacity capable of serving aircraft traffic in accordance with the planned growth of aircraft traffic (Wardani et al., 2017). The dimensions and pavement on this *Apron* are planned to be evaluated using the FAA (*Federal Aviation Administration*) method because this method has the advantage that this method provides a complete and detailed picture of the conditions and types of soil that will be faced in the field and this method is suitable for all weather and various soil classes in the field (Kembauw et al., 2017). This FAA method is also considered more acceptable to variations in aircraft movements and also an increase in the number of aircraft movements in the future (Moetriono & Suryani, 2021). The planned aircraft that will be used in this study is the B-737-900ER aircraft, the B-737-900ER aircraft is the largest aircraft that is often served at Adi Soemarmo Airport (Sinaga et al., 2019).

This research is expected to be able to provide information in the field of transportation, especially air transportation and is also expected to be considered in the evaluation of pavement on Aprons at any airport (Sanjaya & Tamara, 2022).

## RESEARCH METHOD

The research location is in Surakarta City, Central Java Province. Geographically the airport is located at coordinates 07°30´58"S, and 110°45´25"E, with an elevation of 128 m or 419 feet above sea level.

To make it easier to conduct this research, it is necessary to collect data related to "Evaluation of the Dimensions and Thickness of the Adi Soemarmo Surakarta Airport *Apron Pavement* Using the FAA (*Federal Aviation Administration*) Method". The data needed in this study are as follows.

1. Data Primer

   The primary data used in this study was obtained through direct interviews regarding the actual condition of the airport.

2. Secondary Data

   The secondary data used in this study was obtained from the General Manager of PT. Angkasa Pura I Branch Office of Adi Soemarmo Surakarta International Airport. The required data are as follows.

   a. *Apron* pavement structure data
   b. Design technical data
   c. Traffic movement data for the last 10 years
   d. Data *CAD Apron*

## RESULT AND DISCUSSION

1. Air traffic data

   Data on air traffic movements is needed in performing the role or designing the pavement thickness of airport airside facilities. Data on aircraft movements is needed in forecasting the growth rate of aircraft at airports. It takes at least 10 years or at least the last 5 years to forecast the movement of the aircraft. Data on aircraft movements at Adi Soemarmo Surakarta Airport from 2010 to 2019 can be seen in Table 1.

**Table 1**
**Adi Soemarmo Surakarta Airport Departure Data**
(Angkasa Pura I, 2020)

| Year to- | Year | Aircraft departure (units) |
|---|---|---|
| 1 | 2010 | 20503 |
| 2 | 2011 | 21381 |
| 3 | 2012 | 22703 |
| 4 | 2013 | 23899 |
| 5 | 2014 | 24895 |
| 6 | 2015 | 25942 |
| 7 | 2016 | 26461 |
| 8 | 2017 | 27001 |

| | | |
|---|---|---|
| 9 | 2018 | 28423 |
| 10 | 2019 | 29733 |

Based on aircraft departure data at Adi Soemarmo Airport, aircraft departures have increased from 2010 to 20 19, in 201 0-2019 aircraft movements increased from 20,503 to 29,733. The movement of aircraft at Adi Soemarmo Surakarta Airport can be seen in Figure 5. 10.

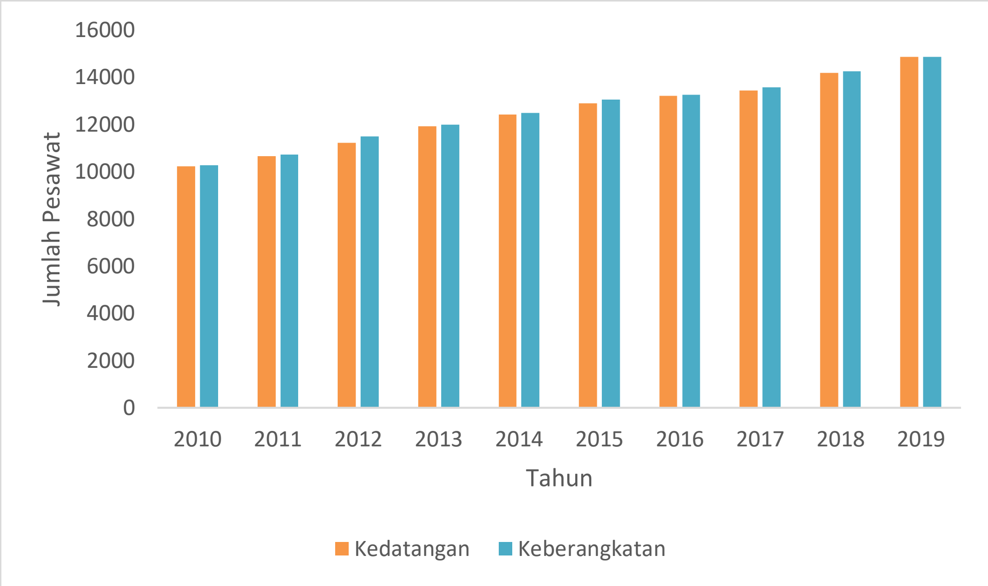


**Figure 1**
**annual aircraft movements of Adi Soemarmo Surakarta Airport An upward trend**

The evaluation on the *pavement* of the Adi Soemarmo Surakarta Airport apron is using annual aircraft departure data. The number of aircraft departures taken is in 2019 which has been divided based on the type or type of aircraft operating at the airport. The number of aircraft departures in 2019 by aircraft type or type can be seen in Table 2

**Table 2**
**Number of aircraft departures in 2019 (Angkasa Pura I, 2020)**

| No. | Aircraft Type | Number of aircraft movements | Percentage of aircraft type (%) |
|---|---|---|---|
| 1 | Boeing 737 - 300 | 286 | 0,96 |
| 2 | Boeing 737 - 400 | 74 | 0,25 |
| 3 | Boeing 737 - 500 | 152 | 0,51 |
| 4 | Boeing 737 - 700 | 4688 | 15,77 |
| 5 | Boeing 737 - 800 | 6727 | 22,62 |
| 6 | Boeing 737 – 900ER | 10555 | 35,50 |
| 7 | Airbus 320 – 200 | 5801 | 19,51 |
| 8 | ATR 72 – 600 | 1348 | 4,53 |
| 9 | Cessna 208 | 102 | 0,34 |
| | Sum | 29733 | 100 |

Based on Table 2 the number of aircraft departures as a whole will be used in calculating the pavement thickness of the *apron.*

2. Air traffic data for the next 20 years

Air traffic data for the next 20 years is needed in forecasting or predicting the number of aircraft and passenger movements in the future at Adi Soemarmo Surakarta Airport so that it can serve the flight needs of the community for the better in the city of Surakarta. The *forecasting* method used in airport design is the *time series* method.

a. *Time series* method

Analysis with a simple linear regression model was carried out with the help of *microsoft excel software* using the data in Table 3 for aircraft departures in the last 10 years, namely 2010 to 2019 so that an equation of the number of aircraft movements was obtained as in Figure 2

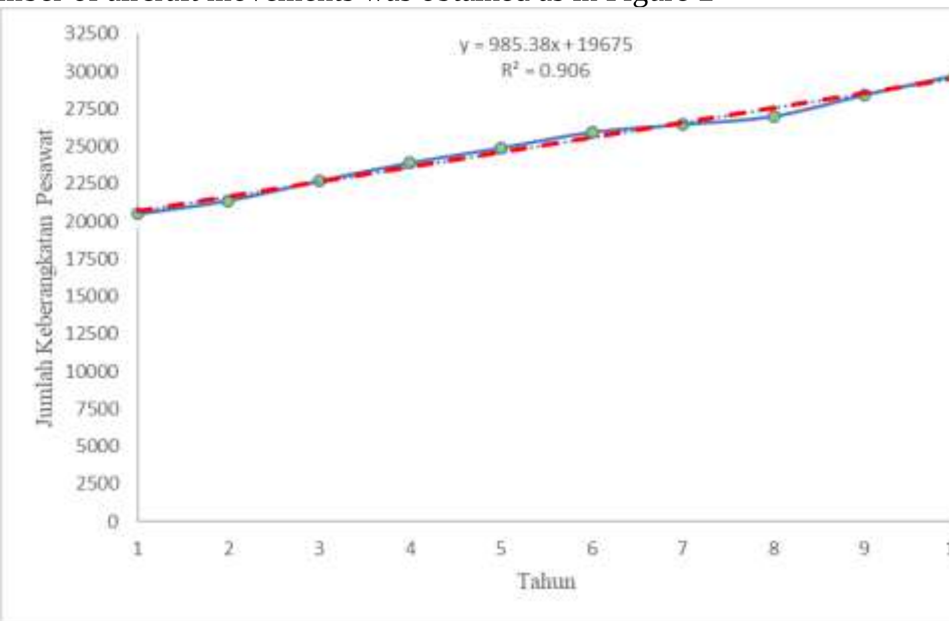


**Figure 2**
**growth of the number of departures of Adi Soemarmo Surakarta Airport aircraft in 2010 – 2019 with a linear regression trendline**

From figure 5.11 above, a linear regression equation is obtained, namely:

$$y = 985.38x + 19675$$ ( **Error! No text of specified style in document.**. 1 )

With the value of the coefficient of determination R2 = 0.906, where that variable x (year) has a simultaneous effect on variable y (number of aircraft departures) by 90.6%.

**Table 3**
**Results of *forecasting* the departure of a 20-year aircraft using equations (5.1)**

| Year | Period to - (x) | y = a + bx |
|---|---|---|
| 2020 | 11 | 30514 |
| 2021 | 12 | 31500 |
| 2022 | 13 | 32485 |
| 2023 | 14 | 33470 |
| 2024 | 15 | 34456 |
| 2025 | 16 | 35441 |
| 2026 | 17 | 36426 |
| 2027 | 18 | 37412 |
| 2028 | 19 | 38397 |
| 2029 | 20 | 39383 |
| 2030 | 21 | 40368 |
| 2031 | 22 | 41353 |
| 2032 | 23 | 42339 |
| 2033 | 24 | 43324 |
| 2034 | 25 | 44310 |
| 2035 | 26 | 45295 |
| 2036 | 27 | 46280 |
| 2037 | 28 | 47266 |
| 2038 | 29 | 48251 |
| 2039 | 30 | 49236 |

From the table above, it is known that the prediction of the number of departures of Adi Soemarmo Surakarta Airport aircraft for 2039 is 49,236 aircraft. In addition to using this *time series* method , forecasting can also be done using the *exponential smoothing* model

**Table 4**
**Results of *forecasting* aircraft departures in the next 20 years with *exponential smoothing* model**

| Year | Period to - (x) | $y = a + e^{bx}$ |
|---|---|---|
| 2020 | 11 | 34620 |
| 2021 | 12 | 36384 |
| 2022 | 13 | 38238 |
| 2023 | 14 | 40186 |
| 2024 | 15 | 42234 |
| 2025 | 16 | 44386 |
| 2026 | 17 | 46648 |
| 2027 | 18 | 49025 |

**Table** Error! No text of specified style in document.
**Results of *forecasting* aircraft departures for the next 20 years with *exponential smoothing* model (Continued)**

| Year | Period to - (x) | $y = a + e^{bx}$ |
|---|---|---|
| 2028 | 19 | 51523 |
| 2029 | 20 | 54149 |
| 2030 | 21 | 56908 |
| 2031 | 22 | 59807 |
| 2032 | 23 | 62855 |
| 2033 | 24 | 66058 |
| 2034 | 25 | 69424 |
| 2035 | 26 | 72961 |
| 2036 | 27 | 76679 |
| 2037 | 28 | 80586 |
| 2038 | 29 | 84693 |
| 2039 | 30 | 89008 |

By using *trendline exponential smoothing*, the value of the coefficient of determination is obtained, namely R2 = 0.9855 which means that the variable X (year) has a simultaneous effect on variable Y (number of aircraft departures) by 98.55% by obtaining the number of aircraft movements in 2039 as many as 89,008 aircraft.

Based on forecasting traffic data for 20 years for the upcoming Adi Soemarmo Surakarta Airport using the time series method, the number of aircraft departures in 2039 used in the calculation is taken from the results of forecasting analysis using the *time series* method with an *exponential smoothing* model, namely 89,008 aircraft with a fairly high R2 value of = 0, 9855 which is close to the value of 1.

3. Number of aircraft in the next 20 years

To obtain the number of aircraft that will be in operation in the next 20 years, an analysis will be carried out on the movement of aircraft during peak hours which is carried out by formulating in advance the value of the coefficient of demand for air traffic transportation during peak hours using Equation (3.7), Equation (3.8), and Equation (3.9). As for the number of aircraft that will park on the *apron*, it can be calculated using Equation (3.10). *Gate occupancy time* is used for operational optimization purposes where waiting and parking time arrangements are carried out on the *apron*. *Gate occupancy time* can be seen on the Boeing 737 – 900ER aircraft type based on Table 3.1, which is 45 minutes.

a. Calculating peak clock volume in 2010

$$M_d = \frac{M_y}{365}$$

$$M_d = \frac{20.503}{365}$$

$$M_d = 56{,}17$$

$$C_p = \frac{1{,}38}{\sqrt{M_d}}$$

$$C_p = \frac{1{,}38}{\sqrt{56{,}17}}$$

$$C_p = 0{,}18$$

$$M_p = M_d \text{ x } C_p$$

$$M_p = 56{,}17 \text{ x } 0{,}18$$

$$M_p = 8{,}75 \approx 9 \ Pesawat$$

The number of aircraft parked on the *apron* in 2010

$$N = \frac{C \text{ x } T}{60} + A$$

$$N = \frac{9 \text{ x } 45}{60} + 1$$

$$N = 9 \ Pesawat$$

b. Calculating peak clock volume in 2015

$$M_d = \frac{M_y}{365}$$

$$M_d = \frac{25.942}{365}$$

$$M_d = 71{,}07$$

$$C_p = \frac{1{,}38}{\sqrt{M_d}}$$

$$C_p = \frac{1{,}38}{\sqrt{71{,}07}}$$

$$C_p = 0{,}163$$

$$M_p = M_d \text{ x } C_p$$

$$M_p = 11.63$$

$$M_p = 11{,}63 \approx 12 \ Pesawat$$

The number of aircraft parked on the *apron* in 2015

$$N = \frac{C \text{ x } T}{60} + A$$

$$N = \frac{12 \text{ x } 45}{60} + 1$$

$$N = 10 \ Pesawat$$

c. Calculating peak clock volume in 2020

$$M_d = \frac{M_y}{365}$$

$$M_d = \frac{34,620}{365}$$
$$M_d = 94,85$$
$$C_p = \frac{1,38}{\sqrt{M_d}}$$
$$C_p = \frac{1,38}{\sqrt{94,85}}$$
$$C_p = 0,142$$
$$M_p = M_d \text{ x } C_p$$
$$M_p = 13,43$$
$$M_p = 13,43 \approx 14 \; Pesawat$$

The number of aircraft parked on the *apron* in 2020

$$N = \frac{C \text{ x } T}{60} + A$$
$$N = \frac{14 \text{ x } 45}{60} + 1$$
$$N = 11 \; Pesawat$$

d. Calculating peak clock volume in 2025

$$M_d = \frac{M_y}{365}$$
$$M_d = \frac{44.386}{365}$$
$$M_d = 121,61$$
$$C_p = \frac{1,38}{\sqrt{M_d}}$$
$$C_p = \frac{1,38}{\sqrt{121,61}}$$
$$C_p = 0,125$$
$$M_p = M_d \text{ x } C_p$$
$$M_p = 15,22$$
$$M_p = 15,22 \approx 15 \; Pesawat$$

Number of planes parked on the *apron* by 2025

$$N = \frac{C \text{ x } T}{60} + A$$
$$N = \frac{15 \text{ x } 45}{60} + 1$$
$$N = 12 \; Pesawat$$

e. Calculating peak clock volume by 2030

$$M_d = \frac{M_y}{365}$$
$$M_d = \frac{56.908}{365}$$
$$M_d = 155,91$$

$$C_p = \frac{1,38}{\sqrt{M_d}}$$
$$C_p = \frac{1,38}{\sqrt{155,91}}$$
$$C_p = 0,11$$
$$M_p = M_d \text{ x } C_p$$
$$M_p = 17,23$$
$$M_p = 17,23 \approx 17 \; Pesawat$$

Number of aircraft parked on the *apron* by 2030

$$N = \frac{C \text{ x } T}{60} + A$$
$$N = \frac{17 \text{ x } 45}{60} + 1$$
$$N = 14 \; Pesawat$$

f. Calculating peak clock volume by 2035

$$M_d = \frac{M_y}{365}$$
$$M_d = \frac{72.961}{365}$$
$$M_d = 199,89$$
$$C_p = \frac{1,38}{\sqrt{M_d}}$$
$$C_p = \frac{1,38}{\sqrt{199,89}}$$
$$C_p = 0,097$$
$$M_p = M_d \text{ x } C_p$$
$$M_p = 19,51$$
$$M_p = 19,51 \approx 20 \; Pesawat$$

Number of aircraft parked on the *apron* by 2035

$$N = \frac{C \text{ x } T}{60} + A$$
$$N = \frac{20 \text{ x } 45}{60} + 1$$
$$N = 16 \; Pesawat$$

g. Calculating peak clock volume in 2039

$$M_d = \frac{M_y}{365}$$
$$M_d = \frac{89.008}{365}$$
$$M_d = 243,85$$
$$C_p = \frac{1,38}{\sqrt{M_d}}$$

$$C_p = \frac{1{,}38}{\sqrt{243{,}85}}$$
$$C_p = 0{,}088$$
$$M_p = M_d \text{ x } C_p$$
$$M_p = 21{,}55$$
$$M_p = 21{,}55 \approx 22 \ Pesawat$$

Number of aircraft parked on the *apron* by 2039

$$N = \frac{C \text{ x } T}{60} + A$$
$$N = \frac{22 \text{ x } 45}{60} + 1$$
$$N = 17 \ Pesawat$$

The number of aircraft parked on the *apron* from 2010 to 2039 as a whole can be seen in Table 6.

**Table 6**

**Number of aircraft that will park on the *apron* from 2010 – 2039 as a whole**

| Year | Number of Aircraft Departures | Md | Cp | Mp | N |
|---|---|---|---|---|---|
| 2010 | 20503 | 56.17 | 0.184 | 10 | 9 |
| 2011 | 21381 | 58.58 | 0.180 | 11 | 9 |
| 2012 | 22703 | 62.20 | 0.175 | 11 | 9 |
| 2013 | 23899 | 65.48 | 0.171 | 11 | 9 |
| 2014 | 24895 | 68.21 | 0.167 | 11 | 10 |
| 2015 | 25942 | 71.07 | 0.164 | 12 | 10 |
| 2016 | 26461 | 72.50 | 0.162 | 12 | 10 |
| 2017 | 27001 | 73.98 | 0.160 | 12 | 10 |
| 2018 | 28423 | 77.87 | 0.156 | 12 | 10 |
| 2019 | 29733 | 81.46 | 0.153 | 12 | 10 |
| 2020 | 34620 | 94.85 | 0.142 | 13 | 11 |
| 2021 | 36384 | 99.68 | 0.138 | 14 | 11 |
| 2022 | 38238 | 104.76 | 0.135 | 14 | 12 |
| 2023 | 40186 | 110.10 | 0.132 | 14 | 12 |
| 2024 | 42234 | 115.71 | 0.128 | 15 | 12 |
| 2025 | 44386 | 121.61 | 0.125 | 15 | 12 |
| 2026 | 46648 | 127.80 | 0.122 | 16 | 13 |
| 2027 | 49025 | 134.32 | 0.119 | 16 | 13 |
| 2028 | 51523 | 141.16 | 0.116 | 16 | 13 |
| 2029 | 54149 | 148.35 | 0.113 | 17 | 14 |
| 2030 | 56908 | 155.91 | 0.111 | 17 | 14 |
| 2031 | 59807 | 163.86 | 0.108 | 18 | 14 |
| 2032 | 62855 | 172.21 | 0.105 | 18 | 15 |
| 2033 | 66058 | 180.98 | 0.103 | 19 | 15 |
| 2034 | 69424 | 190.20 | 0.100 | 19 | 15 |
| 2035 | 72961 | 199.89 | 0.098 | 20 | 16 |

| | | | | | |
|---|---|---|---|---|---|
| 2036 | 76679 | 210.08 | 0.095 | 20 | 16 |
| 2037 | 80586 | 220.78 | 0.093 | 21 | 16 |
| 2038 | 84693 | 232.03 | 0.091 | 21 | 17 |
| 2039 | 89008 | 243.86 | 0.088 | 22 | 17 |

Based on the data in Table 6 above, it is known that the aircraft that will park in the year will continue to grow in the next 20 years. The number of aircraft that will park on *apron* Bandara Adi Soemarmo Surakarta in 2039 is 17 aircraft. Currently, the apron condition of Adi Soemarmo Surakarta airport is able to accommodate as many as 15 aircraft considering that Adi Soemarmo Airport is one of the Hajj embarkation airports in Indonesia which is designed to have large dimensions. Interestingly, outside the Hajj month, Adi Soemarmo Surakarta Airport is more often used for small aircraft with an apron capacity that can accommodate 15 aircraft This airport is still able to accommodate an increase in aircraft movements until 2034 and must begin to add *apron* dimensions in 2039.

## Design of Apron dimensions for the next 20 years by ICAO and FAA methods

Geometric design using ICAO and FAA methods is carried out by determining the dimensions of the *apron* using Boeing 737-900ER type aircraft for the next 20 years. The dimensions of the Boeing 737-900ER type aircraft can be seen in Figure 7

The design of the *apron* area according to ICAO and FAA can be determined using Table 7 and 8 to obtain dimensions according to the distance of each letter code (code letter ), *code letter* is a calculation according to the wingspan (*wingspan*) and *outer main gear wheel span* (width / outermost wheelbase of the aircraft) required. Adi Soemarmo Surakarta Airport with 15 *aircraft stands* and has a code *letter*, namely code 4-E.

**Figure 7**
**growth of the number of departures of Adi Soemarmo Surakarta Airport aircraft in 2010 – 2019 with a linear regression trendline**

| ***Aerodrome Code Letter* (ICAO)** | ***Minimum Clearance*** | | |
|---|---|---|---|
| | ***Between Aircraft and Fixed or Moveble Object* (C)** | ***Aircraft Stand Taxilane Centre Line to Object* (B)** | ***Apron Taxiway Centre Line to Object* (A)** |
| A | 3,0 m | 12,0 m | 16,25 m |
| B | 3,0 m | 16,5 m | 21,5 m |
| C | 4,5 m | 24,5 m | 26,0 m |
| D | 7,5 m | 36,0 m | 40,5 m |
| And | 7,5 m | 42,5 m | 47,5 m |
| F | 7,5 m | 50,5 m | 57,5 m |

**Table 8**
**Minimum clearance on the apron according to the FAA**

| ***Code Letter* (FAA)** | ***Nose to Building Clearance* (E)** | ***Between Aircraft and Fixed or Movable Object* (C)** |
|---|---|---|
| A | 9,0 m | 4,5 m |
| B | 6,0 m | 7,6 m |
| C | 6,0 m | 7,6 m |
| D | 4,5 m | 7,6 m |
| And | 4,5 m | 7,6 m |

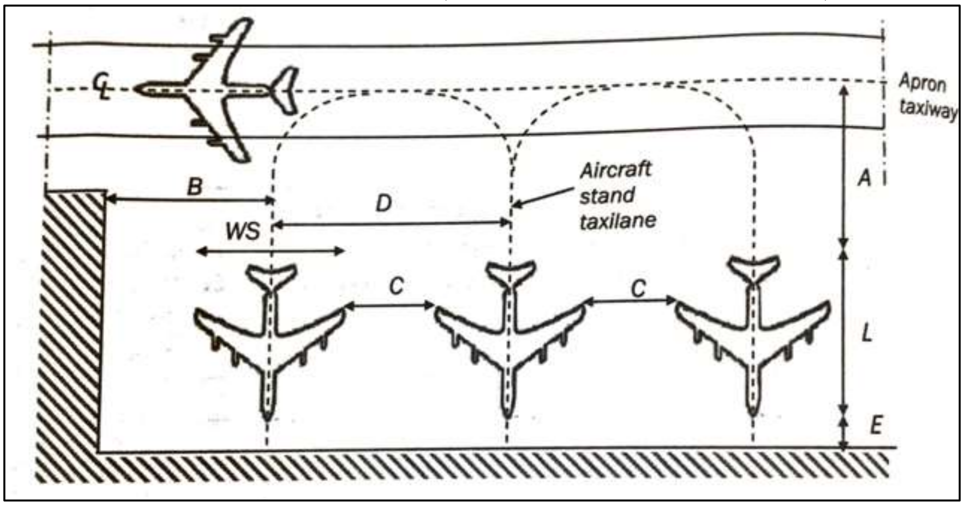


**Figure 3**
**Minimum required clearance (Sartono et al., 2015)**

Based on Figure 5.6, Table 5.8 and Table 5.9 using Boeing 737-900ER aircraft, the following data are obtained:
*Wingspan* (WS) = 35,75 m
*Length* (L) = 40,67 m
A (*Apron Taxiway Centre Line to Object*) = 47,5 m
B (*Aircraft Stand Taxilane Centre Line to Object*) = 42,5 m
C (*Between Aircraft and Fixed or Moveble Object*) = 7,5 m
D (*Minimum distance between aircraft stand taxilane center line*) = WS + C
= 35,75 + 7,5
= 43,25 m
E (*Nose to Building Clearance*) = 4,5 m
Then the width and length of the apron can be calculated using the data above, namely as
next:
*Apron* length = (2 x B) + (11 x D)
= (2 × 42.5) + (11 × 43.25) = 560.75 m ≈ 560 m
Apron width = E + L + A + 1/2 WS
= 4.5 m + 40.67 m + 47.5 m + 17.875 m

= 110.545 m ≈ 110 m (used width of the existing *apron* i.e. 135 m)

*Apron* dimensions = Apron length x *apron* width
= 560 m x 135 m
= 75.600 $m^2$

The calculation results of the combination of the length and width of the apron have potential considering the condition of the available land and with this combination the *apron* is able to accommodate aircraft at Adi Soemarmo Surakarta Airport for the next 20 years for the Boeing 737-900ER type with *an aircraft stand* of 17 aircraft. This type of aircraft was chosen because it is the largest aircraft currently landing and parking at Adi Soemarmo Surakarta Airport (Randika, 2017). The *apron* design uses a *nose-in* type aircraft parking configuration where the aircraft parks perpendicular to the terminal building and is close to the terminal building. This is done because with this configuration the area of land used is smaller and the noise level is lower because there is no *jet blast* leading to the aircraft terminal building.

This *nose-in* type aircraft parking configuration can also make it easier for passengers to board the plane by using a ramp as a direct passenger link to the aircraft. In the existing condition, the area of the apron of Adi Soemarmo Surakarta Airport is 420 m × 1 35 m. In the next 20 years where it requires an area of 560 m × 135 m, it is necessary to increase the length of the apron to be able to meet the needs of the *apron* in the future. A sketch of the *apron layout* for existing conditions and the next 20 years can be seen in Figure 3 and Figure 4 (Suharyat, n.d.).

## CONCLUSION

Based on the purpose of the study and the results of the evaluation and discussion, the evaluation of the pavement of the Adi Soemarmo Surakarta Airport apron using the FAA method can be drawn as follows.

The results of the calculation of apron dimensions were obtained by 560 m × 135 m while the dimensional conditions of the existing apron were 420 m × 135 m. Based on the results of these calculations, it is necessary to increase the apron length by 140 m, while for the width of the apron there is no need to widen so that the apron is able to serve aircraft traffic optimally for the next 20 years at Adi Soemarmo Surakarta Airport.

The movement of the aircraft calculated using the forecasting method of time series with exponential smoothing for the next 20 years obtained 89,008 aircraft departures which value was then used in the calculation of the thickness of the apron pavement.

The results of the calculation of the thickness of the apron pavement using the FAA method were obtained as follows:

The thickness of the existing rigid pavement on the apron is obtained, namely the final thickness of the concrete slab by 40 cm, the base course by 15 cm and the subbase course by 30 cm, while for the final thickness of the rigid pavement for the next 20 years, a concrete slab of 44 cm, a base course of 15 cm and a subbase course of 30 cm are needed. Based on the results of stress, deflection, and fatigue calculations, the stiff pavement thickness for the next 20 years, which is 44 cm, can be used because the results obtained from voltage, deflection, and fatigue are in accordance with the requirements.

The difference in calculation differences between the results of the analysis of the thickness of the apron pavement

## REFERENCES


Angkasa Pura I. (2020). *Arus Pergerakan Lalu Lintas Angkutan Udara Berdasarkan Type Bandara : Adi Soemarmo Soc Tahun 2010-2019*.

Huzeirien, & Dahlan, M. E. (2018). Analisa Perencanaan Perkerasan Kaku (Rigid Pavement) Apron Bandar Udara Sultan Thaha Syaifuddin Jambi. *Jurnal Civronlit Unbari*, *2*(2), 24. Https://Doi.Org/10.33087/Civronlit.V2i2.19

Kembauw, E., Sinay, L. J., & Sahusilawane, A. M. (2017). *Pembangunan Perekonomian Maluku*. Deepublish.

Moetriono, H., & Suryani, A. (2021). Analisis Perpanjangan Runway Bandar Udara Internasional Adi Soemarmo Solo Jawa Tengah. *Jurnal Extrapolasi*, *18*(01).

Randika, D. (2017). *Analisis Faktor-Faktor Yang Mempengaruhi Pendapatan Sopir Taksi (Studi Kasus Taksi Gemah Ripah Kota Bandung)*. Fakultas Ekonomi Dan Bisnis Unpas Bandung.

Razi, M., & Sumberdaya, I. (2014). *Peranan Transportasi Dalam Perkembangan Suatu Wilayah*. Bogor: Ilmu Ekonomi Konsentrasi Pembangunan Sumberdaya, Universitas Nusa Bangsa.

Sanjaya, A. R., & Tamara, A. P. (2022). Kualitas Kinerja Petugas Imigrasi Di Bandar Udara Internasional Adi Soemarmo Boyolali Surakarta Di Masa Pandemi Covid-19 Pada Tahun 2021. *Ground Handling Dirgantara*, *4*(01), 134–140.

Sartono, W., Dewanti, D., & Rahman, T. (2015). Bandar Udara. *Ugm Press*.

Sefaji, G. Y., Soedwiwahjono, S., & Nurhadi, K. (2018). Kesiapan Aksesibilitas Stasiun Solo Balapan Dalam Melayani Trayek Kereta Api Penghubung Bandara Adi Soemarmo Dan Kota Surakarta. *Region: Jurnal Pembangunan Wilayah Dan Perencanaan Partisipatif*, *13*(1), 50–63.

Setyaningsih, B. E. (2010). *Pengaruh Kualitas Jasa Terhadap Kepuasan Penumpang Pesawat Terbang Di Bandara Internasional Adi Soemarmo Surakarta*.

Sinaga, O., Suprayogi, A., & Nugraha, A. L. (2019). Analisis 3d Modelling Untuk Deteksi Obstacle Zona Kkop Bandara Adi Soemarmo. *Jurnal Geodesi Undip*, *9*(1), 217–226.

Suharyat, Y. (N.D.). Sektor Pertahanan Dan Keamanan Negara. *Dampak Perkembangan Transportasi Di Berbagai Sektor*, 71.

Suryanto, A., Hudhiyantoro, & Hary, M. (2021). Analisis Perpanjangan Runway Bandar Udara Internasional Adi Soemarmo Solo Jawa Tengah. *Extrapolasi*, *18*(1), 10–24. Https://Doi.Org/10.30996/Exp.V18i1.5209

Wardani, E. D., Wisnu Setiawan, S. T., & Arch, M. (2017). *Bandara Internasional Terpadu Adi Soemarmo Baru Dengan Pendekatan Arsitektur Tourism*.

Universitas Muhammadiyah Surakarta.
Wicaksono, A. A. (2018). *Perencanaan Fasilitas Sisi Udara Pada Bandara Internasional Ahmad Yani Semarang*. Institut Teknologi Sepuluh Nopember.