Declared distance calculation in Runway Rumpin Airfield

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Declared Distance Calculation in Runway Rumpin Airfield

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Abstract. Rumpin airfield is located in Bogor, West Java with latitude -6.373 and longitude 106.622 degrees with ICAO code WI1C. Rumpin airfield is used for civil and military purposes. The problem is the runway marking of safety not yet shown. To support the flight activities especially for take-off and landing, needed the calculation of declared distance. Declared distance is operational distance to notify the Pilot for take-off, landing and cancellation take-off safely. This Study introduces an approach to know the value of Take-off run available (TORA), Take-off distances available (TODA), Accelerate-stop distance available (ASDA) and Landing distance available (LDA). The calculations are carried out in accordance with Director General Decree No. 39 Year 2015 concerning Manual of Standard Civil Aviation Safety Regulations (CASR) Part 139 regarding Airports (Aerodromes). The calculations results are TORA, ASDA and LDA about 1111 m and the TODA about 1151 m. The runway qualifications in accordance with ICAO - Annex 14 Vol.1 Aerodrome Design and Operations 2015 using runway type B.

INTRODUCTION

Aircraft is any machine supported for flight in the air by buoyancy or by the dynamic action of air on its surface. According to ANNEX 6 part I "Any machine that can derive support in the atmosphere from the reactions of the air other than the reactions of the air against the earth's surface."[1] Aircraft has advantages compared to other transportation such as land and sea transportation in terms of wider range and time savings of its journey.

With many enthusiasts in the use of air transportation, related parties such as airlines, and airline service providers, namely airports, have taken various steps to meet customer needs that are increasing from time to time. Airport is a system because it consists of components that interact with and support each other that produce a service product to meet customer needs in their activities, including in research activities. So that in compliance these needs, it's necessary to give attention to the supporting factors that support the flight activities, especially from the runway area for take-off and landing.

In the runway area, there are areas which are boundaries of the aircraft must take-off landing, stop, etc. which called "Declared Distance". Declared distances are incorporated into the Operations Specifications of commercial aircraft operators that are part of the air carrier certificates and operations certificates issued by FAA under 14 CFR Part 119. So, to know about the declared distance in the Runway Rumpin Airfield, the author will conduct research related to "Declared Distance Calculation on Runway Rumpin Airfield".

The regulations for the certification of aircraft take-off and landing distance requirement have changes over the years, partly in recognition of the changes in aircraft technology but partly also improve the overrun safety performance.[2] Declared distance is needed as operational distances notified to a pilot for take-off, landing or safely aborting a take-off. These distances are used to determine whether the runway is adequate for the proposed landing or take-off or to determine the maximum payload permissible for a landing or take-off.

The limitation of this paper is described about declared distance calculation consisting of TODA, TORA, ASDA and LDA. The purpose of this paper is to provide supplementary guidance to aerodrome operators on the calculation of declared distance for runway direction at develop aerodrome.

LITERATURE REVIEW

Runway Code Classification

The regulations define the minimum legal distance that needs to be available for take-off or landing by imposing margins of field performance on the demonstrated minimum distances.[3] The margins are designed to capture sufficient of the deviations from best practice operation to meet the safety objectives. The protection of the aircraft in remaining cases in then to be achieved by sympathetic design of the airfield.[4]

The first step in airport planning is to determine the runway length limit. From the type of aircraft provided, it's necessary to know the characteristic of the aircraft (the reference attached in attachment) to make it easier to know the minimum runway length used after several tests carried out by the aircraft manufacturer (Aero-plane Reference Field Length).

TABLE 1. Aerodrome Reference Code (ARC)

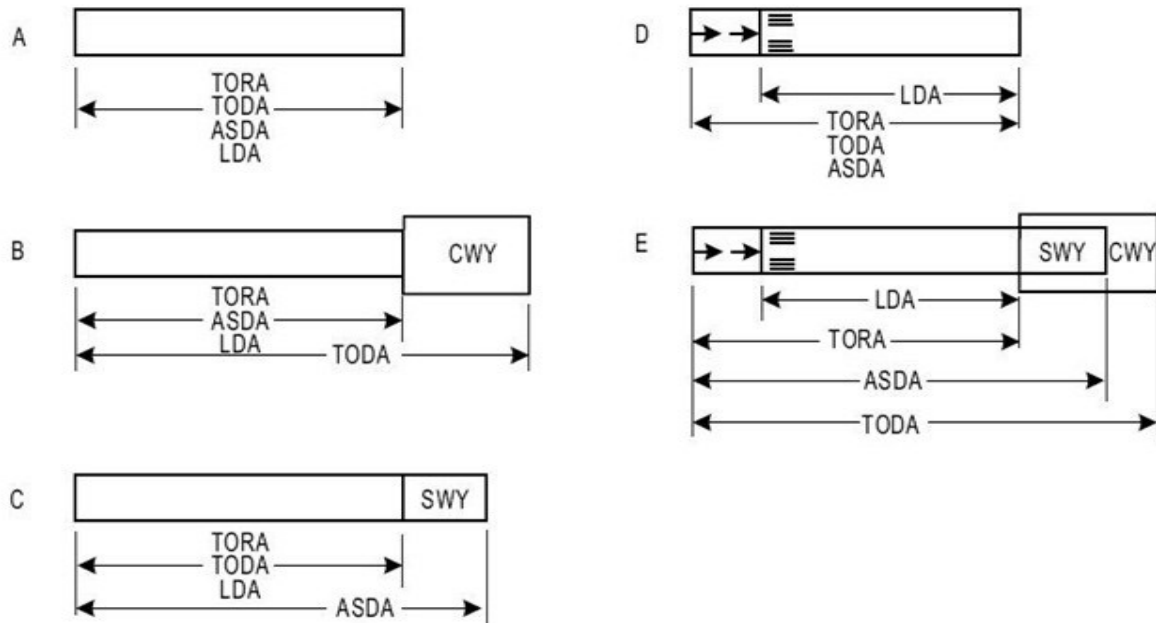| Code Element I		Code Element II		
Code Number	*ARFL (m)*	*Letter Code*	*Wingspan (m)*	*The Outer Distance of The Main Wheel*
1	< 800	A	< 15	< 4.5
2	800-1200	B	$15 - 24$	$4.5 - 6$
3	1200-1800	C	$24 - 36$	$6 - 9$
4	> 1800	D	$36 - 52$	$9 - 14$
		E	$52 - 65$	$9 - 14$
		F	$65 - 80$	$14 - 16$

Declared Distance Calculation

FIGURE 1. Declared Distance Illustration

From the illustration above, there are names that may still be unfamiliar among the public, so that the understanding and calculation of how to obtain value is necessary. There are five declared distance for runway:

a. Take Off Distance Available (TODA) the length of the takeoff run available plus the length of the clearway, if clearway is provided.[5]

$$TODA = TORA + CWY \qquad (1)$$

b. Take Off Run Available (TORA). The length of runway declared available and suitable for the ground run of an airplane taking off.[5]

$$TORA = \text{length ARFL take-off} \qquad (2)$$

c. Accelerate-Stop Distance Available (ASDA). The length of the take-off run available plus the length of stop-way, if provided.[5]

$$ASDA = TORA + SWY \qquad (3)$$

d. Landing Distance Available (LDA). The length of runway which is declared available and suitable for the ground run of an aero-plane landing.[5]

$$LDA = \text{length ARFL landing LDA} \qquad (4)$$

TODA and LDA illustrate the operation status of the airside of an airport better than distance of runway because most airside have a clearway that is important to an aircraft's take-off.[6]

TABLE 2. Width Runway Minimum

Code Number	Code Letter					
	A	B	C	D	E	F
1	18 m	18 m	23 m	-	-	-
2	23 m	23 m	30 m	-	-	-
3	30 m		30 m	45 m	-	-
4	-	-	45 m	45 m	45 m	60 m

From

declared the classification width runway from aerodrome.

TABLE 3. Runway Strip Dimension

Description	Code Letter			
	1	2	3	4
Length of runway strip				
c. Instrument runway	60 m	60 m	60 m	60 m
d. Non- instrument runway	30 m	60 m	60 m	60 m
Width of runway strip				
d. Instrument precision approach runway	150 m	150 m	300 m	300 m
e. Instrument non-precision approach runway	90 m	90 m	150 m	300 m
f. Non- instrument runway	60 m	80 m	150 m	150 m
The Tilt of the Transverse Runway Strip	3%	3%	2.5%	2.5%
The Tilt of the Longitudinal Runway Strip	2%	2%	1.75%	1.5%

METHODOLOGY

The methodology of research is collecting data of the detail data of Rumpin Airfield based on literature. After that, determine the Aerodromes Reference Code (ARC) from Rumpin Airfield based on Table 2 and Table 3. From the ARC, we will get the clearway of runway (CRW). From CRW, we can calculate the TODA, TORA and LDA. After we get this variable, we must validation by Director General Decree No. 39 Year 2015.
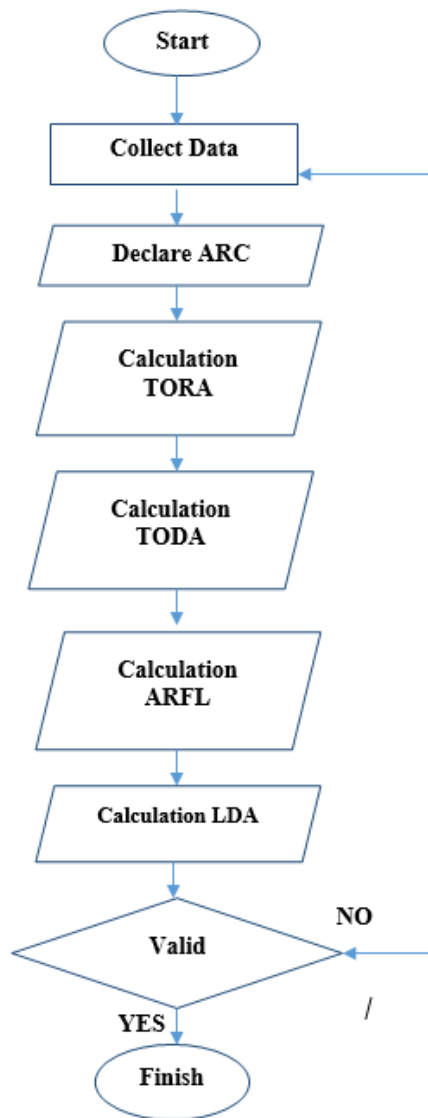
FIGURE 2. Flowchart

RESULT AND DISCUSSION

Rumpin Airfield Details

Rumpin airfield is located in Bogor, West Java with coordinate Latitude 06-22-23.5919S (-6.373220), Longitude 106-37-19.2059E (106.622002) and elevation 223 feet MSL (68 m MSL). The dimension of runway is 1024 m x 16 m.[7]

Based on Aerodrome Reference Code (ARC), the classification of Rumpin Airfield is 2B class. From the table 3, declared that the code letter is 2 with Instrument non-precision approach runway for runways strip. The length of runway Strip is 60 m and the width of Runway Strip is 90 m. Based on Director General Decree No. 39 Year 2015, to determine the length of the clearway for codes 3 and 4 must have a length of more than 150 meters. Specifically, for codes 1 and 2 using the following calculation:

$$\text{Length of Clearway} = (\text{max. } 0.5 \times \text{ARFL take-off}) \qquad (5)$$

From Eq. (5) get the length of clearway of the runway is 40 m.

Declared Distance Calculation

The declared distances shall be calculated to the nearest meter for each runway direction. These declared distances comprise of the take-off run available (TORA), take-off distance available (TODA), accelerate-stop distance available (ASDA) and landing distance available (LDA). According to the Eq. (1), (2), (3) and (4), get the results are:

TORA = ASDA = LDA = Length of ARFL take-off = 1111 m
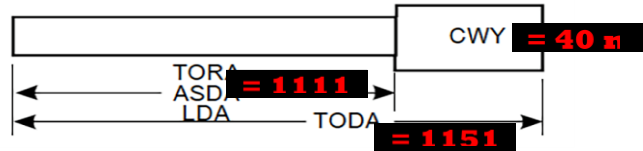TODA = TORA + CWY
        = 1111 + 40

FIGURE 3. Length Runway Illustration

Calculation of Length Runway in Some Situations

a. Normal Take-Off Situation
A normal takeoff is one in which the airplane is headed into the wind, or the wind is very light. Also, the takeoff surface is firm and of sufficient length to permit the airplane to gradually accelerate to normal lift-off and climb-out speed, and there are no obstructions along the takeoff path.

TODA = 1.15 x ARFL take-off   = 1277.65 m
LODA = 0.55 x TODA   = 702.7 m
CW   = 0.5 x [TODA – (1.15 x LODA)] = 234.77 m
TORA = TODA – CW   = 1042.88 m
FL   = FS + CW (FS = TORA)   = 1277.65 m

b. Normal Landing Situation
A normal approach and landing involves the use of procedures for what is considered a normal situation; that is, when engine power is available, the wind is light, or the final approach is made directly into the wind, the final approach path has no obstacles and the landing surface is firm and of ample length to gradually bring the airplane to a stop.

LD   = TODA   = 1277.65 m
SD   = 0.6 x LD   = 766.59 m
CW   = 0.5 x (TODA – LODA)   = 287.475 m
SW   = 0.05 x LD   = 63.8825 m

c. Take Off Over Shoot Situation
LD   = TODA   = 1277.65 m
LODA = 0.75 x TODA   = 958.2375 m
CW   = 0.5 x (TODA – LODA)   = 159.70625 m
SW   = 0.05 x LD   = 63.8825 m

d. Engine Failure Situation

Regulations on takeoff with engine trouble, in addition a clearway (empty area) is also needed a stopway (stop line) or in some cases it could be just one of them. Stopway is needed where the area the plane will cancel takeoff. Thus, the regional stopway must have a pavement that is strong enough to not damage the plane stopped at the stop.

LD	= TODA	= 1277.65 m
SD	= 0.6 x LD	= 766.59 m
CW	= 0.15 x LD	= 191.6475 m
SW	= 0.05 x LD	= 63.8825 m
FL	= TORA + SW (TORA=ARFL)	= 1174.882 m

e. Poor Approach Situation

LD	= TODA	= 1277.65 m
SD	= 0.6 x LD	= 766.59 m
CW	= 0.15 x LD	= 191.6475 m
SW	= 0.05 x LD	= 63.8825 m

CONCLUSION

Based on the calculation of the research conducted, the value of the declared distance for TODA is 1151 m, TORA, ASDA, LDA is 1111 m and CWY is 40 m. This information can be helpful for airlines, air crew (pilots, FOO, etc.) and also aircraft operators.

If at the time the plane takes off and the speed is still below the speed specified for take-off, the pilot can slow down again speed until the end of the stop-way (SW). The runway system is considered to be the main airport capacity planning parameter. This is reasonable, considering that building a new runway is a huge infrastructural project for an airport, both in terms of investment and capacity gain (in aircraft operations per hour).[7] As an illustration, runway which is one of the air side facilities has its own standards related to certain technical indicators from the time of planning the facility.

Each facility will have a certain standard value based on the calculations specified in the regulations referred to Ref. 8.

Declared distances may be used to obtain additional RSA and/or ROFA prior to the runway's threshold (the start of the LDA) and/or beyond the stop end of the LDA and ASDA, to mitigate unacceptable incompatible land uses in the RPZ, to meet runway approach and/or departure surface clearance requirements, in accordance with airport design standards, or to mitigate environmental impacts. Declared distances may also be used as an incremental improvement technique when it is not practical to fully meet these requirements. However, declared distances may only be used for these purposes where it is impracticable to meet the airport design standards or mitigate the environmental impacts by other means, and the use of declared distances is practical.[9]

An airport facility is divided into two main parts namely the land side and the air side. The air side component consists of a runway, exit taxiway, holding pad, and taxiway system and apron-gate area.[10]

ACKNOWLEDGEMENT

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