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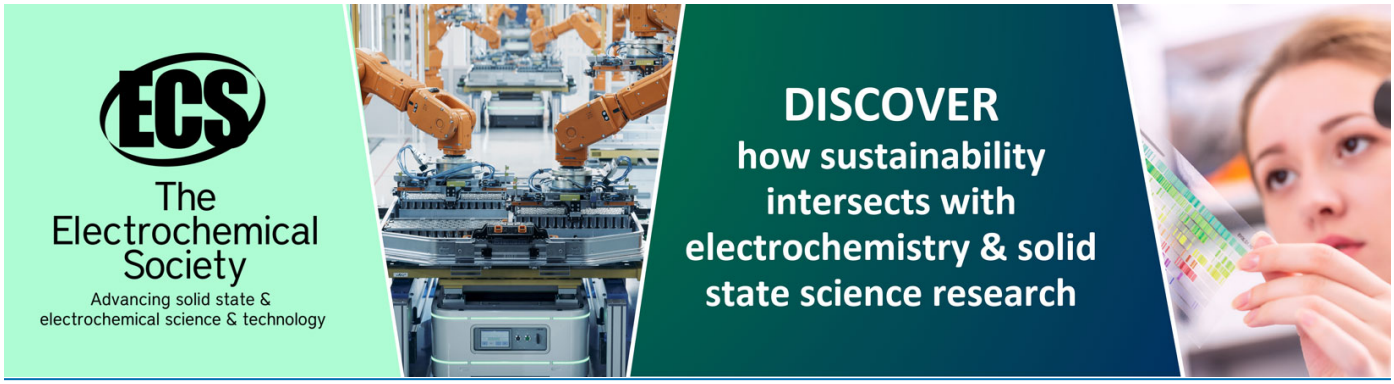
To cite this article: Kelly V Khoemarga and Anissa Noor Tajudin 2020 *IOP Conf. Ser.: Mater. Sci. Eng.* **852** 012013



IOP Conf. Series: Materials Science and Engineering **852** (2020) 012013 doi:10.1088/1757-899X/852/1/012013

Structural design of airport runway Case study: Jos Orno Imsula MOA Airport

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Abstract. Jos Orno Imsula MOA Airport is a SATPEL class airport. This airport is a potential services airport. Jos Orno Imsula MOA airport has an existing runway with the dimensions of 1400 m x 30 m, with azimuth direction 10 – 28, and 60 cm pavement thickness. This study aim to redesign the geometric and pavement thickness of runway. The methods used in this study are Aeroplane Reference Field Length (ARFL) method for calculating the length of the runway, and Federal Aviation Administration (FAA) method for calculating the pavement thickness of runway. The analysis shows that the dimension of runway required is 1260 x 30 m, and the pavement thickess required is 45 cm.

1. Introduction

Runway is one of the critical part of an airport, that is why structural design of runway is very important. Runway length must be sufficient to provide operational requirements of the aircraft. Factors which have a bearing on the runway length to be provided are performance charateristic and operating masses of the aeroplanes to be saved, weather (particularly surface wind and temperature), runway charateristics such as slope and surface condition, and aerodrome location factors [6].

Airfield pavement is intended to provide a smooth and safe all-weather riding surface that can support the weights of such heavy objects as aircraft on top of the natural ground base. A pavement consisting of a mixture of bituminous material and aggregate placed on high quality granular materials is referred to as flexible pavement [5]. Flexible pavement is consists of surface course, base course, and subbase course [1]. In a typical conventional flexible pavement, known as asphalt pavement, the surface course usually consists of two bituminious layers – a wearing course, and a binder course [4]. A base course is defined as the layer of material that lies immediately below the wearing surface of a pavement, and the subbase is a layer of material between the base and subgrade [10]. The soil base and the volume and weight of the traffic using the pavement are two primary factors that contribute to the thickness of pavement layers.

The airport selected for this study is Jos Orno Imsula Airport MOA, Maluku Barat Daya because this aiport is potentially developing. The existing thickness of runway pavement is 60 cm. 10 cm for surface course, 20 cm for the base course, and 30 cm for the subbase course. The aircraft used for runway structural design is ATR 42 – 300.

2. Method

The method used for runway length calculation is ARFL method. The actual runway length is the length obtained after applying the corrections of temperature, elevation, and slope. The actual runway length should be adequate to meet the operational requirements of the aircraft for which runway is designed and should not be less than the longest length determined by applying the corrections for local conditions to the operation and performance charateristic [8]. The length is calculated as follow [1]:

2.1. Elevation

$$Fe = 1 + 0{,}07\ \frac{h}{300}$$

where:
Fe : elevation correction factor
h : elevation above sea level (m)

2.2. Temperature

$$Ft = 1 + 0{,}01\ (T - (15 - 0{,}0065h))$$

where:
Ft : temperataure correction factor
T : airport temperature (^{o}C)

2.3. Slope

$$Fs = 1 + 0{,}1\ S$$

where:
Fs : slope correction factor
S : runway slope (%)

The method used for runway pavement thickness is FAA method. The FAA method is a pavement design method developed by the Federation Aviation Administration and refers to the FAA Advisory Circular (AC) pavement standard [3], and in the design process using the charts provided by FAA. The parameter for FAA method are design aircraft charateristic, annual departure of designated aircraft, and CBR data [9]. The steps of FAA method are: (1) define the main landing gear configuration; (2) define the designated aircraft, (3) determine the main gear wheel load, (4) calculate the equivalent annual departure of designated aircraft, (5) define the total thickness of pavement [7]. The designated aircraft selection is not based of the structural take-off weight of aircraft, but the largest number of annual departures.

3. Results and Discussion

3.1. Runway Geometric

The actual runway length required for aircraft ATR 42 – 300 is 1260 m for take off, and 1020 m for landing. According to [2], the runway code number and code letter are 3C. Therefore, the design for runway width, runway shoulder, stopway, runway strip, runway end safety area (RESA), and clearway can be resolved based on [2], as shown in Table 1.

Table 1 Comparison between analysis and existing condition of runway geometric

Parameter	Analysis (m)	Existing (m)
Runway length	1260	1400
Runway width	30	30
Runway strip	60 x 150	60 x 150
RESA	90 x 150	90 x 150
Clearway	630 x 150	150 x 150
Stopway	60 x 30	-

The actual length required for ATR 42 – 300 is 1260 m, and the existing runway length is 1400 m, so there is no need to extend the runway length to provide for aircraft ATR 42 – 300.

3.2. Runway Flexible Pavement Thickness

Design of runway flexible pavement for aircraft ATR 42 – 300 is using the dual wheel gear graphic, with subgrade CBR 6 %, and was designed for 20 years after 2017 (2037) as shown in Figures 1.

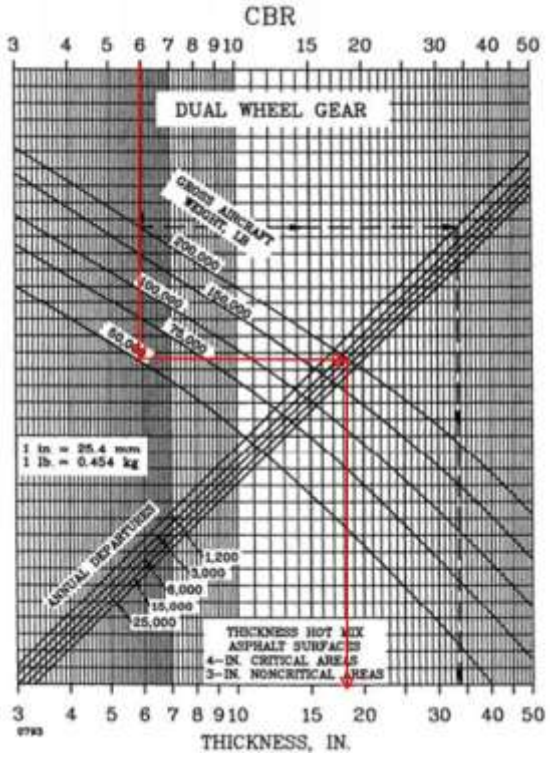

Figure 1 Dual Wheel Gear Graphic [3]

The total pavement thickness is 18 inch (45 cm), and the surface course thickness is 4 inch (10 cm). Figure 2 is used to define the minimum base course thickness.

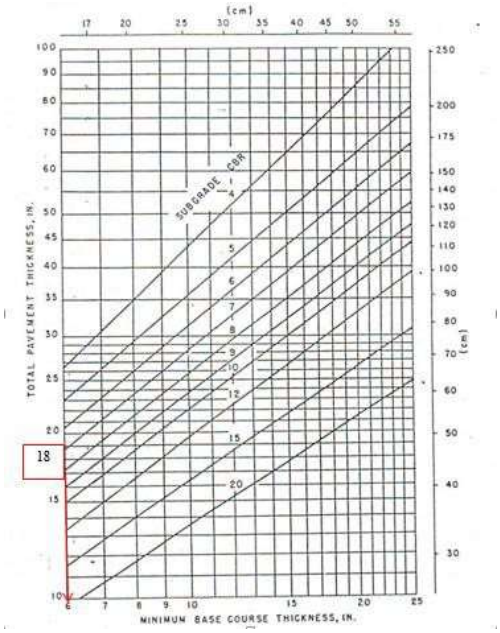

Figure 2 Minimum Base Course Thickness [3]

According to Figure 2, minimum base course thickness needed is 6 inch (15 cm). Because the thickness of the surface course and base course are known, the thickness of the subbase course can be known by substracting total thickness – surface course – base course = 45 cm – 10 cm – 15 cm = 20 cm. Table 2 show the comparison between analysis and existing condition of runway pavement.

Table 2 Comparison between analysis and existing condition of runway pavement

Methods	FAA	Existing
Surface (cm)	10	10
Base (cm)	15	20
Subbase (cm)	20	30
Total (cm)	45	60
Subgrade	6%	

The total thickness from FAA method is 45 cm, less than the existing thickness, so there is no need to be overlayed to provide for aircraft ATR 42 – 300. However, since the pavement thickness is less than existing pavement thickness, it also means that the existing pavement can provide higher equivalent annual departure for aircraft ATR 42 – 300. By using the same graphic and the same method, the existing pavement thickness can provide for aircraft ATR 42 – 300 maximum equivalent annual departure (25,000).

3.3. Advantages and Disadvantages of FAA Method

The FAA methods has disadvantages in consider the investigation of bearing capacity of subgrade, because this method only consider the comparative statistic of local condition of soil. The advantages of this method are this method provides a complete and detailed description of the conditions and types of soil that will be encountered in the field, and suitable for all weather conditions and various soil classifications on the field [11].

3.4. Application of Results

According to *Rencana Kerja Kementrian / Lembaga Tahun Kerja* 2020 + 2021, runway length of Jos Orno Imsula Moa airport will be extended from 1400 m to 1600 m. Therefore the length can provide for larger aircrafts operational requiremet. The types of aircraft commonly used at a SATPEL class airport other than ATR 42 – 300 are ATR 42 – 500, ATR 72 – 500, and ATR 72 – 600. The actual length needed for ATR 42 – 500, ATR 72 – 500, and ATR 72 – 600 shown in Table 3.

Table 3 Actual length need for aircrafts ATR 42 – 500, ATR 72 – 500, and ATR 72 - 600

Jenis Pesawat	ATR 42 – 500	ATR 72 – 500	ATR 72 – 600
ARFL (m)	1160	1220	1290
Faktor Koreksi			
Fe (elevasi)	1,0017	1,0017	1,0017
Ft (suhu)	1,1215	1,1215	1,1215
Fs (kemiringan)	1,0150	1,0150	1,0150
Actual length required (m)	1330	1400	1480

The actual length required for aircraft ATR 42 – 500 is less than 1400 m, for aicraft ATR 72 – 500 and ATR 72 – 600 is less than 1600 m. This means that the existing runway with 1400 m length can provide for aicraft ATR 42 – 500 operational requirement (in terms of runway length), and if the runway length is extended to 1600 m, the runway will be able to provide operational requirements for aircraft ATR 72 – 500 and ATR 72 – 600.

4. Conclusion and Reccomendation

4.1. Conclusion

The existing runway geometric is able to provide aircrafats ATR 42 – 300, and ATR 42 – 500, if the length is extend to 1600 m, Jos Orno Imsula MOA airport runway will be able to provide for aircraft ATR 72 – 500, and ATR 82 – 600. The existing runway pavement is able to provide aircraft ATR 42 – 300 until 2037 and until maximum equivalent annual departure (25.000).

4.2. Recommendation

Further research on the land side, apron, taxiway, effects of headwind and tailwind on runway, and drainage at Jos Orno Imsula MOA airport needs to be done considering the growth of passengers that potentially increase every year.

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