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# Planning of Flexible Pavement on Runway at Wiladatika Airport

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**Abstract :** Wiladatika airport is a special airport that does not serve commercial flights but is only used for flights such as flying school, test flights, and joy flights. With flight activities such as the Wiladatika airport runway, it is only a ground pavement covered with grass. For the current condition, the largest aircraft is only cessna 182 with a mtow of (2550 Lb) and there are no problems with the Wiladatika airport runway when taking off. However, the manager of Wiladatika Airport has a plan to be able to land a larger aircraft, namely the ATR 42 with a weight of mtow (36 500 Lb). For this reason, the Wiladatika airport runway must be able to accept a much larger load than the existing aircraft. Therefore, it is necessary to design flexible pavement on the runway at the Wiladatika airport.To plan the flexible feeling on the runway, calculations are used in accordance with KP 93 of 2015. To calculate the feel, CBR data is needed, critical aircraft weight, annual departure, and critical landing gear type. Based on calculations with these regulations, the results for CBR are 4.5%, critical aircraft mtow load is (36 500 Lb), annual departure equivalent of (12150) and dual wheel configuration. The results of these calculations obtained a flexible pavement thickness of 18 inches with 3 layers in the form of a surface layer (4 inches), a sub-base layer (6.9 inches), and a sub-base layer (7.9 inches). The material used for this material is the surface layer using asphalt concrete, for the top foundation using crushed stone, and the bottom foundation using natural aggregate..

**Keywords**: *Wiladatika Airfield, Flexible Pavement, Asphalt, Surface, KP 93 2015*

## INTRODUCTION

Wiladatika airport is an airport that serves non-commercial flights. The largest aircraft it serves is the Cessna 182 with MTOW (2550 Lb). For the existing condition, a runway with pavement from soil that is only covered with grass can still serve the largest aircraft to take off and landing at this time. However, in future plans, the Wiladatika airport manager has plans to land a larger aircraft, such as ATR 42 with MTOW (36 500 Lb). So it is necessary to develop a runway with applicable standards in order to accommodate future aircraft.

### Literature Review

### Pavement

According to KP 94 Tahun 2015 pavement is infrastructure consisting of

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several layers with different strengths and carrying capacities. Pavement structure is generally divided into two types, namely flexible pavement and rigid pavement. Pavement made by mixing asphalt and aggregate on top of a high quality granular material is called flexible pavement, and pavement using slab concrete (Portland cement concrete) is called rigid pavement. (KP 94 2015).

**Rigid Pavement**

According to KP 94 Tahun 2015 hard pavement or cement-concrete pavement is a building (pavement) that uses aggregate as a raw material and cement as a binder. Rigid pavements have different properties from flexible pavements. In hard pavements, the load bearing capacity of the pavement is maintained mainly by concrete slabs. This relates to a type of concrete slab which is very rigid and can spread the load over a large area, creating small stresses on the layer beneath. (KP 94 2015).

**Flexible Pavement**

Flexible pavement is a pavement having elastic qualities, according to KP 94 Tahun 2015. As a result, the pavement will flex when loaded. Instead of bending stresses, flexible road constructions carry loads based on load restrictions. This construction consists of a number of layers made of carefully chosen materials that are intended to transmit the load from the road structure's surface to the layers below. The underlying layer's load capacity must not be exceeded by the load transmitted to it thanks to the flexible pavement design. The subsoil provides total support for the entire flexible track construction. (KP 94 2015).

**METHOD**

The researcher used KP 93 2015 to build the pavement's structure in accordance with the PCN calculation criteria for airport infrastructure in order to plan flexible pavements. The following are the steps in calculating runway planning:

1. Ascertain the segment's CBR

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2. Calculate the corresponding annual departure using the KP 93 of 2015 regulations.
3. Using the KP 93 of 2015 curve, calculate the entire pavement thickness.
4. Determine each layer's thickness.
5. Identify the material for each layer in

**Table 1. 1 Table of annual departure equivalent calculation tabulation**

| | Aircraft type | Wheel Konfig | Aircraft Weight | Annual Departur | Equiv Dual Gear Departure | Wheel Load | Wheel Load Critical Aircraft | Log R2 | (W2/W1)^0,5 | Log R1 | Equiv Annual Departure |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 1 | | | | | | | | | | | |
| 2 | | | | | | | | | | | |
| 3 | | | | | | | | | | | |
| 4 | | | | | | | | | | | |
| 5 | | | | | | | | | | | |
| | | | | | | | | | Total | | |

## DISCUSSION AND RESULT

### Calculation CBR Value

CBR data from four points, each with a distinct value, are shown below :

**Table 1. 2 CBR table calculation**

| Number | CBR Data | same amount | Equal or higher percentage | Result |
|---|---|---|---|---|
| 1 | 3.9 | 4 | 4/4 x 100% | 100.00% |
| 2 | 5.1 | 3 | 3/4 x 100% | 75.00% |
| 3 | 6.4 | 2 | 2/4 x 100% | 50.00% |
| 4 | 6.5 | 1 | 1/4 x 100% | 25.00% |

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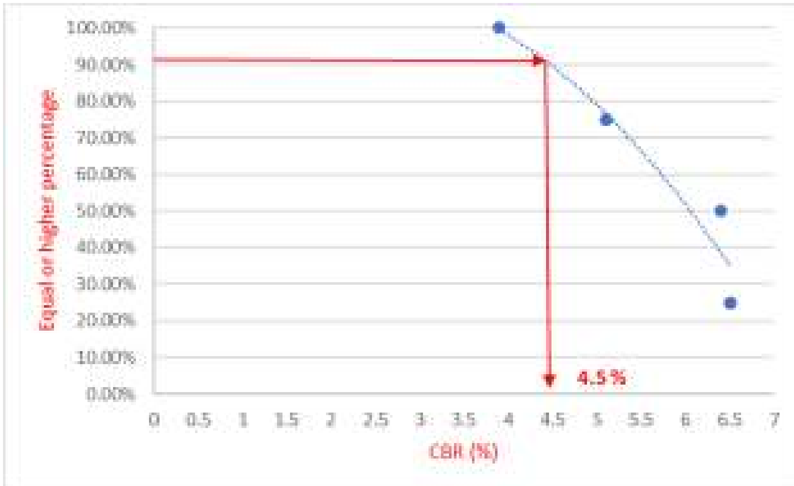
The researcher applied the CBR segment graphical method to identify the CBR segment. Using the graphical technique, the 90 percentile value of the CBR data in one segment serves as the segment's CBR value.




*Source: Researcher Analysis Results*

**Figure 1. 1 Chart for calculating CBR value**

## Calculating the Annual Departure Equivalent

The kind of aircraft, wheel configuration, aircraft load, and yearly departure are the four primary pieces of information needed to calculate the equivalent annual departure. These four pieces of information are then converted to the following computation.

**Table 1. 3 Table of calculation Equivalent Annual Departure results**

| NO | Jenis Pesawat | Konfig roda | Beban pesawat | Annual Departur | Equiv Dual Gear | Beban Roda | Beban Roda Pesawat | Log R2 | (W2/W1)^ 0,5 | Log R1 | Equiv Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 1 | PITSS S2C | Single Wheel | 1700 Lb | 126 | 100.8 | 808 | 8668.75 | 2.00 | 0.30 | 0.60 | 0.6 |
| 2 | CTSW | Single Wheel | 1323 Lb | 77 | 61.6 | 628 | 8668.75 | 1.79 | 0.26 | 0.47 | 2.9 |
| 3 | RV 7 | Single Wheel | 1800 Lb | 125 | 100 | 855 | 8668.75 | 2.00 | 0.31 | 0.62 | 4.1 |
| 4 | Jabiru J430 | Single Wheel | 1540 Lb | 16 | 12.8 | 732 | 8668.75 | 1.11 | 0.29 | 0.32 | 2.0 |
| 5 | Cessna 182 | Single Wheel | 2550 Lb | 45 | 36 | 1211 | 8668.75 | 1.56 | 0.37 | 0.58 | 3.8 |
| | | | | | | | | | Total | | 13.40 |
| Pesawat Kritis | | | | | | | | | | | |
| 6 | ATR 42 | Dual Wheel | 36861 Lb | 1200 | 1200 | 8668.75 | 8668.75 | 3.08 | 1 | 3.08 | 1202 |
| | | | | | | | | | Total | | 1215.40 |

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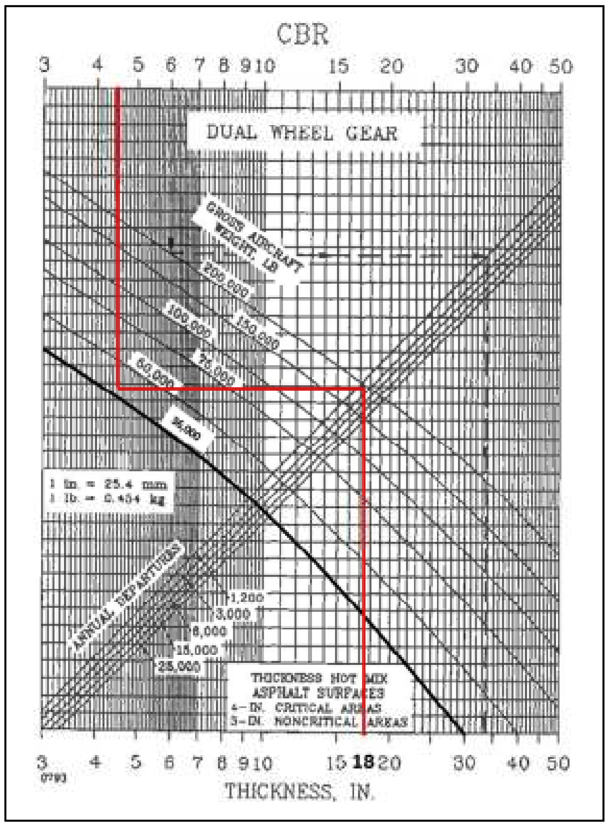
**Calculating the total pavement thickness using KP 93 2015 regulations curve**

The total pavement curve should be plotted on a graph and adjusted based on the type of wheel configuration, MTOW, equivalent annual departure, and CBR of the subgrade to estimate the total thickness of flexible pavement. Due to the minimal standard of annual design on the curve, which is 1200, the design for annual departure will adopt 1200 annual departure, with dual wheel gear configuration, MTOW for the design aircraft of (36500 Lb) and a CBR for subgrade of (4.5%). Plotting the curve below for pavement thickness provides a total thickness of 18 inches (45.72 cm).




*Source: Researcher Analysis Results*

**Figure 1. 2 Plotted curve for total thickness**

**Surface Thickness**

The thickness of the surface can be determined according to table (1.4). The thickness of the surface used is 4 inches.

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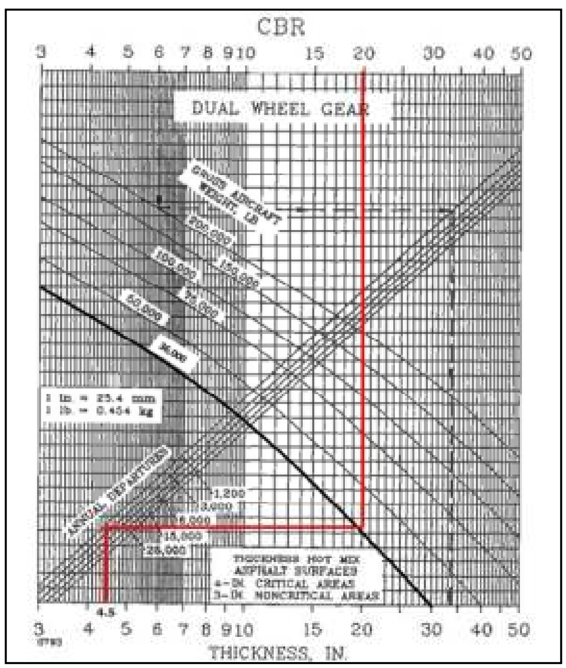
**Table 1. 4 Surface Thickness table**

| No | Pavement Section | Single Wheel and dual Wheel Aircraft | B 747, B 777, dc 10, l 101 Aircraft or Similar Aircraft |
|---|---|---|---|
| 1 | **Critical Area (Wheel lane)** | **10.0 cm (4 inci)** | 12.7 cm (5 inci) |
| 2 | Non Wheel Lane | 7.6 cm (3 inci) | 10.0 cm (4 inci) |

### Subbase Course Thickness

The curve can be used to calculate the total pavement as well as the thickness of the subbase course. For the subbase layer, the CBR value is 20. The results of plotting the curve below get a thickness of 4.5 inches. That is 4.5 inches is the remaining thickness available. Then the results of the current calculation of the thickness of the subbase 18 – 4.5 = 13.5 inches.




*Source: Researcher Analysis Results*

**Figure 1. 3 Plotted curve for subbase course thickness**

### Base Course Thickness

To determine the thickness of the base course by using the curve of the minimum thickness of the base course layer. The result of plotting the curve on the requirement curve for the minimum thickness of the base course layer is 6.9

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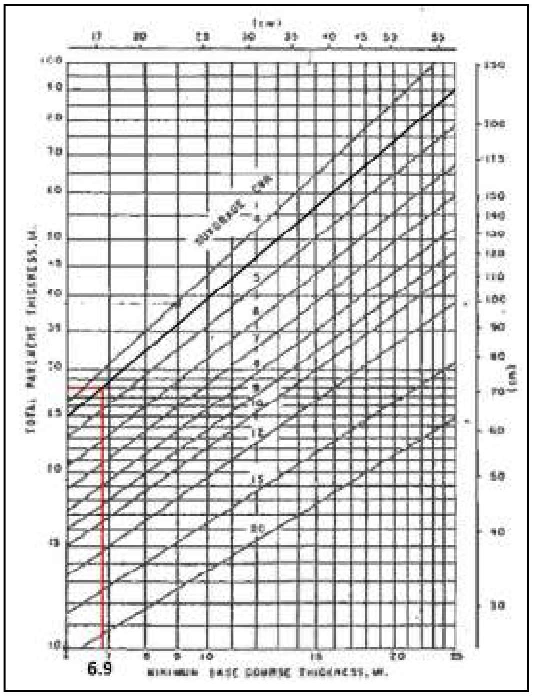
inches as shown in Figure (1.4). Then from the thickness of the base course minus 0.5, which is 6.9 – 0.5 = 6.4. From the results of these calculations, the thickness of the subbase course becomes 13.5 – 6.4 = 7.1 inches.




*Source: Researcher Analysis Results*

**Figure 1. 4 Plotted curve for base course thickness**

## Material for each pavement

To determine the material in each layer, follow the types of materials given by KP 93 2015 in the table (1.5).

**Table 1. 5 Selected material type**

| | |
|---|---|
| P- 501 | Portland Cement Concrete (PCC) |
| **P-401** | **Plant Mix Bituminous Pavements (HMA)** |
| P-403 | Plant Mix Bituminous Pavements (HMA) |
| P- 306 | Econocrete Subbase Course (ESC) |
| P-304 | Cement Trated base Course (CTBC) |
| P- 212 | Shell base Course |
| P- 213 | Sand-Clay Base Course |
| P-220 | Caliche Base Course |
| **P- 209** | **Crushed Aggregate Base Course** |
| P- 208 | Aggregate Base Course |
| P- 211 | Lime Rock Base Course |
| P- 301 | Soil-Cement Base Course |

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| P- 154 | Subbase Course |
|---|---|
| P-501 | Portland Cement Concrete (PCC) |

## Flexible pavement thickness design

According to the calculations, the Wiladatika Airport runway's flexible pavement design shown in figure (1.5) :

**Table 1. 6 implemented pavement materials and thickness**

| No | Layer | Material | Thickness |
|---|---|---|---|
| 1 | Surface Course | P-401 (Plant mix bituminous pavements) | 4 inchi (10.16 cm) |
| 2 | Base course | P-209 (Crushed agregat base course) | 6.9 inchi (15.24 cm) |
| 3 | Subbase Course | P-154 (Subbase Course) | 7.9 inchi (20.32 cm) |
| Total | | | 18 inchi (45.72 cm) |

*Source: Researcher Analysis Results*

**Figure 1. 5 Flexible Pavement Design**

## Specify for ACN and PCN

The following elements must be used and modified to the design plane in order to calculate the PCN :

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1. Determination CBR Subgrade

   Calculation of CBR subgrade based on known CBR subgrade of 4.5%, classified as low with CBR subgrade of 6%, and code C

2. Determination wheel clearance pressure

   The determination of the wheel clearance pressure is seen from the ATR 42 wheel clearance pressure of 0.75Mpa/109Psi Table (1.7), then the wheel clearance pressure category goes into low with the allowable pressure 1.0/145 with code Y.

**Table 1. 7 ACN table for ATR 42**

| Tipe Pesawat | Maximum Apron Mass and Operating Empty Mass | | Load on One Main Gear Leg | Standard Aircraft Tire Pressure | | | ACN relative to | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Rigid pavement subgrades | | | | Flexible pavement | | | |
| | | | | | | | A | B | C | D | A | B | **C** | D |
| | | | | | | | High K = 150 | Medium K = 80 | Low K = 20 | Ultra low K = 20 | High CBR = 15 | Medium CBR = 10 | **Low CBR = 6** | Very low CBR = 3 |
| | **Lbs** | kgs | % | **Psi** | Kg/cm2 | **Mpa** | MN/m² | MN/m² | MN/m² | MN/m² | % | % | **%** | % |
| 1 | **2** | 3 | 4 | **5** | 6 | **7** | 8 | 9 | 10 | 11 | 12 | 13 | **14** | 15 |
| ATR 42 basic Tires | **36.861** | 16.720 | 46.2 | **109** | 7.66 | **0.75** | 9 | 10 | 10 | 11 | 8 | 9 | **10** | 11 |
| | **22.675** | 10.280 | | | | | 5 | 5 | 6 | 6 | 4 | 5 | **5** | 6 |

3. Calculation of PCN value

   To calculate PCN use the following equation :

$$PCN = ACN \min + (ACN\ maks - ACN\ min)\,\frac{P - P\ min}{P\ maks - P\ min}$$

$$PCN = 5 + (10 - 5)\,\frac{36.500 - 22.675}{36.861 - 22.675} = 9.872$$

PCN Recomendation = **9/F/C/Y/U**

## CONCLUSION

To calculate the flexible pavement of the Wiladatika Airport runway using the KP 93 of 2015 regulations, CBR data, annual departure equivalents, and critical aircraft weight are required. The CBR calculated using the CBR segment graphical method in this research represents a value of 4.5%. The aircraft chosen is an ATR-42, which has a weight of (36 500 Lb) for the equivalent annual departure 1215. By plotting the three data using a curve at Kp

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93 2015. The outcomes of the flexible pavement thickness can then be determined.

According to calculations for flexible pavement planning, the entire pavement thickness is 18 inches, or 0.45 meters, and is based on critical aircraft, specifically the ATR 42. Each thickness has a different layer thickness and material, starting with the surface layer, which is made of asphalt concrete and is 4 inches thick, the top foundation layer, which is made of crushed stone and is 6.9 inches thick, and the sub-base layer, which is made of a layer of natural aggregate and is 7.9 inches thick. The design of the runway by using largest aircraft, the ATR 42, which has a wingspan of 24.6 m and an ARFL of 1160 m. According to calculations and regulations, the runway in this design has a length of 1400 m and a width of 30 m.

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