# Assignment 2: Runway Length Analysis

**Solution** Instructor: Trani

Reading Assignment: Read Chapters 1 through 3 of the FAA Advisory Circular 150/5325-4b before working on this homework.

## Problem 1

Design the runway length for a new General Aviation airport to be constructed at a site located 3,400 feet above sea level. A temperature survey at the site indicates a mean daily maximum temperature of the hottest month of 93 degree F. The aircraft fleet mix expected to operate at the airport is shown in Table 1.

Table 1. Expected Aircraft Fleet at Proposed Airport.

| Aircraft Type | Sampled Aircraft | Aircraft Based at Airport |
|---|---|---|
| **Single Engine Piston** | Cessna 172, Cirrus SR-22, Beechcraft Bonanza A36 | 80 |
| **Multi-engine Piston** | Piper Navajo, Cessna 421C and Beechcraft B58 Baron | 20 |

a) Find the recommended runway length required to serve aircraft listed in Table 1. Consider the correction factors if applicable.

All aircraft in Table 1 are general aviation aircraft with fewer than 10 sets. Use the recommended procedure in Chapter 2 of the FAA AC/150/5325-4b. Use Figure 2-1. No information provided to decide on 95% or 100% of the fleet.

Recall, The FAA states that:

a) "95 Percent of Fleet. This category applies to airports that are primarily intended to serve medium size population communities with a diversity of usage and a greater potential for increased aviation activities. Also included in this category are those airports that are primarily intended to serve low-activity locations, small population communities, and remote recreational areas. Their inclusion recognizes that these airports in many cases develop into airports with higher levels of aviation activities."

b) "100 Percent of Fleet. This type of airport is primarily intended to serve communities located on the fringe of a metropolitan area or a relatively large population remote from a metropolitan area."

**For 95% of fleet obtain 4,800 feet needed**

**For 100% of fleet obtain 5,200 feet needed**

**The procedure in Chapter 2 does not require adjustments per Paragraph 206 reproduced below. A 10% increase in takeoff and landing distance adjustment has been built into the solutions shown in Figures 2-1 and 2-2.**

"Other factors, such as relative humidity and effective runway gradient, also have a variable effect on runway length but are not accounted for in certification. However, these other factors were accounted for in the runway length curves by increasing the takeoff or landing distance (whichever was longer) of the group's most demanding airplane by 10 percent for the various combinations of elevation and temperature."

b) If the airport wants to serve small corporate jets such as the Cessna Citation 550, estimate the new runway length requirement.

The Cessna Citation 550 belongs to 75% of the aircraft population in Table 3-1. This aircraft has a maximum takeoff weight greater than 12,500 lb. Use the recommended procedure in Chapter 3 of the FAA AC/150/5325-4b. Use Figure 3-1 to estimate the basic runway length required. No information provided to decide on 60% or 90% useful load graph.

**For 60% useful load graph obtain 5,900 feet needed**

**For 90% useful load graph obtain 8,600 feet needed (climb limited)**

These values need to be corrected for wet pavement conditions (landing) and gradient ( takeoff).No gradient information provided so use wet pavement correction. The FAA rule states:

*" By regulation, the runway length for turbojet-powered airplanes obtained from the "60 percent useful load" curves are increased by 15 percent or up to 5,500 feet (1,676 meters), whichever is less. By regulation, the runway lengths for turbojet powered airplanes obtained from the "90 percent useful load" curves are also increased by 15 percent or up to 7,000 feet (2,133 meters), whichever is less. No adjustment is necessary by regulation for turboprop-powered airplanes."*

Corrected Runway Lengths (corrected for wet pavement conditions)

**For 60% useful load 5,900*1.15 feet = 6,785 feet is greater than 5,500 feet. Hence use 5,900 feet needed**

**For 90% useful load 8,600* 1.15 = 9890 feet is greater than 7,000 feet needed. Hence use 8,600 feet (climb limited)**

c) Estimate the runway length to support medium size corporate jets such as the Cessna Citation 680 Sovereign and the Raytheon Hawker 400. Comment on the differences found in parts (a-c).

Both the Hawker 400 and Cessna Sovereign are listed in Table 3-1. The solution is the same as shown in part (b).

## Problem 2

a) Explain in simple terms the effect of temperature on runway length.

A temperature increases, density of air decreases. Density plays a role in the generation of thrust by a jet or reciprocating engine. Hence as density decreases, the thrust or force produced by the engine is reduced. The second effect is that as density decreases, stalling (hence approach and takeoff) speed increases.

$$V_s = \sqrt{\frac{2mg}{\rho S C_{l\max}}}$$

$V_s = \text{stalling speed (m/s)}$

$m = \text{aircraft mass (kg)}$

$\rho = \text{air density (kg/m}^3\text{)}$

$S = \text{wing area (m}^2\text{)}$

$C_{l\max} = \text{maximum lift coefficient (dim)}$

$g = \text{acceleration of gravity (m/s}^2\text{)}$

b) Explain in simple terms the effect of airfield elevation on runway length.

A airfield elevation increases, density of air decreases. Density plays a role in the generation of thrust by a jet or reciprocating engine. Hence as density decreases, the thrust or force produced by the engine is reduced. The second effect is that as density decreases, stalling (hence approach and takeoff) speed increases.

## Problem 3

The airport manager of Virginia Tech Montgomery County wants to extend the runway to accommodate Large corporate jets such as the Cessna Citation X (model 650) and the Falcon 900. Find the runway length needed to accommodate such aircraft.

The Cessna Citation 650 and the Falcon 900 belong to 100% of the aircraft population in Table 3-2 in Chapter 3 of the FAA 150/5325-4b. Use the recommended procedure in Chapter 3 of the FAA AC/150/5325-4b. Use Figure 3-2 to estimate the basic runway length required. Since the airport is in a rural area use the 60% useful load graph.

**For 60% useful load graph obtain 6,100 feet needed (uncorrected)**

These values need to be corrected for wet pavement conditions (landing) and gradient ( takeoff). The FAA rule states:

" By regulation, the runway length for turbojet-powered airplanes obtained from the "60 percent useful load" curves are increased by 15 percent or up to 5,500 feet (1,676 meters), whichever is less. By regulation, the runway lengths for turbojet powered airplanes obtained from the "90 percent useful load" curves are also increased by 15 percent or up to 7,000 feet (2,133 meters), whichever is less. No adjustment is necessary by regulation for turboprop-powered airplanes."

**Wet pavement - 6,100 * 1.5 = 7,015 feet needed but correction is limited to 7,000 feet (per above paragraph)**

**Gradient correction. BCB has 0.4% grade. Rule is increase 10 feet for each 1 foot of difference in elevations between centerline points. For a 4,540 foot runway, this translates into 18 foot difference.**

**Gradient - 6,100 + (18 * 10) = 6,280 feet**

**The wet pavement correction dominates and thus the runway should 7,000 feet. A 2,460 feet extension will be needed.**

## Problem 4

Corrections were made in your individual solutions.