Assignment 2: Runway Length Analysis for Small Aircraft

Date Due: September 11, 2022 Instructor: Trani

Reading Assignment: Review Chapters 1 and 2 of the FAA Advisory Circular 150/5325-4b. Also review the course notes Aircraft Runway Length Estimation (http://128.173.204.63/cee4674/cee4674_pub/runway_calculations_Aircraft_upTo_60000lbs.pdf).

Problem 1

Use the Small Aircraft Runway Length Analysis Tool (SARLAT) to **design a runway** at a new airport located 3,400 feet above mean sea level conditions. The average of the maximum daily temperature of the hottest month of the year is 82 degrees Fahrenheit. Table 1 shows the representative aircraft at the airport. To obtain the SARLAT tool follow the links in the class notes.

a) Find the required runway length needed to satisfy the runway performance requirements of the fleet mix in Table 1. For the critical aircraft, list the following runway lengths: 1) dry runway takeoff distance, 2) wet runway takeoff distance, 3) dry landing distance, and 4) wet landing distance. Use the default "useful load" parameters included in SARLAT (100% for piston aircraft and 90% for turboprop and jet-powered aircraft).

b) The FAA Airport Improvement Program (AIP) pays for a **dry takeoff runway** and a **wet landing runway**. Find the runway length that the FAA AIP Program may approve. State the critical aircraft and the condition used (i.e., takeoff or landing).

c) If the airport client wants to pay additionally for a runway that satisfies wet takeoff conditions, estimate the runway length needed. State the critical aircraft used in the design.

d) Show the SARLAT bar chart of runway length requirements for each individual aircraft for your solution.

e) Compare the SARLAT solution with the current FAA runway length requirement recommendation for aircraft with more than 10 seats (see course notes). Comment on the differences observed.

Table 1. Aircraft Fleet Mix for Problem 1.

Aircraft Type	Aircraft	Useful Load (%)	Picture
Piston	Cirrus SR22	100	
Piston	Cessna 421C	100	

Aircraft Type	Aircraft	Useful Load (%)	Picture
Turboprop	Beechcraft King Air B200	90	
Turboprop	Pilatus PC-12	90	
Jet	Cessna CitationJet 1	90	
Jet	Phenom 300	90	

Problem 2

Use the Small Aircraft Runway Length Analysis Tool (SARLAT) to **evaluate a runway extension** for an airport to better serve large turboprop and business jet aircraft. The **existing airport, in Madison County, North Carolina,** has a 4,700 foot runway and the airfield elevation is 1,850 feet above mean sea level conditions. The runway has a grade of 0.5%. Find the maximum daily temperature of the hottest month of the year using the Climate Explorer web site (https://crt-climate-explorer.nemac.org/). Table 2 shows the existing aircraft fleet mix operating at the airport.

Table 2. Future Aircraft Fleet Mix for Problem 2.

Aircraft Type	Aircraft	Percent of Fleet Mix (%)	Picture
Piston	Cessna 172	40	
Piston	Cirrus SR20	20	
Piston	Cessna 402	5	
Turboprop	Beechcraft King Air B350ER	10	
Turboprop	Pilatus PC-12	10	

Aircraft Type	Aircraft	Percent of Fleet Mix (%)	Picture
Jet	Cessna CitationJet 1	5	
Jet	Honda Jet 420	10	
Total		100	

For **existing runway length condition** answer the following:

a) For dry runway conditions, find the maximum **takeoff weight** and **useful load** for the Beechcraft King Air B350ER, the Honda Jet 420, and Cessna CitationJet 1 operating from the existing runway (i.e., 4,700 feet).

b) How many miles can the King Air B350ER fly with 10 passengers for the estimated useful load estimated in part (a)?

For the **proposed runway extension** answer the following:

c) If the runway is extended to 5,300 feet, find the improved useful load parameters for the Beechcraft King Air B350ER and the Honda Jet 420.

d) Comment on the significance of adding 600 feet to the existing runway. Use the table below (or consult the mission range, useful load tables in SARLAT) that applies to the Beechcraft King Air B350ER. More specifically, estimate the additional aircraft range that can be flown in the King Air B350ER after the runway extension.

Table assumes a full load of passengers except when mission range requires off loading passengers to carry more fuel.

For example: a mission range of 300 nm carrying 10 passengers is equivalent to 61.5% useful load for this aircraft.

Mission Range (nm)	Maximum Number of Passengers	Useful Load (%)
100	10	50.4
150	10	53.5
200	10	56.4
300	10	61.5
600	10	73.7
1000	10	87.0
1316	10	97.4
1400	10	100.0
1500	9	100.0
1600	8	100.0
1700	7	100.0
1800	6	100.0
1900	5	100.0
2223	3	100.0

Problem 3

Use the Small Aircraft Runway Length Analysis Tool (SARLAT) to **design a runway** for a small airport to serve exclusively Light Sport Aircraft (LSA). The proposed airport is located 2,350 feet above mean sea level conditions. The average of the maximum daily temperatures of the hottest month of the year is 85 degrees F. Table 3 shows the aircraft fleet mix for this problem.

Table 3. Aircraft Fleet Mix for Problem 3. All Aircraft are LSA Aircraft.

Aircraft Type	Aircraft	Useful Load (%)	Picture
Piston	Flight Design CTLS	100	
Piston	Vans RV-12	100	

a) Find the required runway length needed to satisfy the runway performance requirements of the fleet mix in Table 3. For the critical aircraft, list the following runway lengths: 1) dry runway takeoff distance, 2) wet runway takeoff distance, 3) dry landing distance, and 4) wet landing distance. Use the default useful load parameters programmed in SARLAT (100% for piston aircraft).

b) Find the runway length that the FAA AIP Program may approve. State the critical aircraft and the runway condition used (i.e., takeoff or landing).

c) Show the SARLAT bar chart of runway length requirements for each individual aircraft for your solution.

d) Compare the SARLAT solution with the **current FAA runway length requirement recommendation** for LSA aircraft (see course notes). Comment on the differences observed.

Problem 4

Use the SARLAT tool to estimate the takeoff runway length needed for the Cessna Citation 560 XL (see Figure 1).

a) Find the required runway length at sea level conditions, a design temperature condition of 90 deg. Fahrenheit, 80% load factor and zero runway grade.

b) Repeat part (a) for the same temperature conditions but airport elevations of 1000, 2000, 3000, 4000, and 5000 feet.

c) Make a plot to show the airport elevation (in the x-axis) versus the takeoff runway length required (in the y-axis).

d) What conclusion can you make about the takeoff runway length as a function of airport elevation for a turbofan powered aircraft. Is the variation of takeoff runway length linear with airport elevation?

Figure 1. Cessna Citation 560 XL. The Other Hokie Bird.