Assignment 3: Runway Length Calculations for Large Aircraft

Date Due: September 20, 2024 Instructor: Trani

Problem 1

Estimate the runway length required to operate an Airbus A220-300 from a regional airport with a **desired takeoff weight of 145,000 lbs**. The **design temperature is ISA +15 degrees Celsius**. The airport elevation is 3,000 feet. The characteristics of the Airbus 220-300 can be found in the Airbus Documents for Airport Design (https://aircraft.airbus.com/en/customer-care/fleet-wide-care/airport-operations-and-aircraft-characteristics/aircraft-characteristics). The latest document for the Airbus A220 is: BD500-3AB48-13800-00 Issue No. 006.

Table 1. Aircraft Considered in Problem 1. Airbus A220-300 Landing at Norfolk Airport. Source: A. A. Trani.

Aircraft Considered
Airbus A220-300 with Pratt and Whitney Pure PowerTM PW1521G engines (21,000 lbs of thrust). The aircraft maximum takeoff weight is 156,300 lb. The airline uses a standard seating capacity of 140 seat. The Analysis for Problem 1 Uses a Desired Takeoff Weight of 145,000 lbs. Given the Airfield and Temperature Conditions.


a) Find the runway length needed to operate the Airbus A220-300 with the Pratt and Whitney PW1521G engine (21,000 lbs of thrust) at 145,000 lbs. from the regional airport.

b) Find the runway length needed to operate the Airbus A220-300 with the Pratt and Whitney PW1524G engine (24,000 lbs of thrust) at 145,000 lbs. from the regional airport.

c) Compare the two solutions above. Briefly explain the causality between engine thrust and the runway length needed to take off at the same weight.

d) Make a recommendation to the airline about which engine (PW1521G or PW1524G) to buy to reduce runway length.

Problem 2

Design a new runway for an international airport located 2,323 feet above sea level conditions near **Guadalajara, Spain**. The critical aircraft is the Boeing 787-9 (see picture below). The airline operator wants to fly nonstop 4,800 nautical miles (Great Circle Distance) with a full passenger load and an additional 25,000 lbs. of cargo.

The temperature at the site can be found at Weather Spark: https://weatherspark.com/y/36868/Average-Weather-in-Guadalajara-Spain-Year-Round#Sections-Temperature. If you need to find the ISA atmospheric values, you can use the table in the notes (you need to interpolate) or use a web site like Digital Dutch (https://www.digitaldutch.com/atmoscalc/).

Table 1. Aircraft Considered in Problem 1. Boeing 787-9 Landing at Atlanta Hartsfield-Jackson Airport. Source: A. A. Trani.

Aircraft Considered
Boeing 787-9 with Rolls-Royce Trent 1000 **Hi-Thrust Engines** engines. The aircraft maximum design takeoff weight is 561,500 lbs. The airline uses an aircraft with 290 seats in a two-class layout.


a) Find the design distance flown using the Great Circle Flight Path and adjust as needed. The additional distance accounts for actual Air Traffic route conditions and to account for possible weather deviations.

b) Use the Weather Spark website cited above to find the mean daily maximum temperature of the hottest month (design temperature) at the airport location.

c) Find the difference between ISA conditions at the airport site and the design temperature.

d) Estimate the Operating Empty Weight (OEW) as the lowest value in the payload-range diagram.

e) Find the Desired Takeoff Weight (DTW) to fly the proposed route. Assume a 100% passenger load factor in your analysis and add 25,000 lbs. of cargo. Clearly state the fuel weight, operating empty weight, and payload carried. In your calculations, use the passenger weights discussed in class.

f) Find the runway length needed to fly the critical route. Assume a modest 0.2% grade for the new runway.

g) Find the maximum cargo load that could be carried in the 4,800 nm (GCD) trip before reaching the Brake Energy or the Tire Speed limits.