Hochschule für Angewandte Wissenschaften Hamburg
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DEPARTMENT FAHRZEUGTECHNIK UND FLUGZEUGBAU

Balanced Field Length Calculation for a Learjet 35A/36A with Underwing Stores on a Wet Runway

Task for a Bachelor thesis according to university regulations

Background

Eleven aircraft of type Learjet 35A and Learjet 36A are operated by the company GFD Gesellschaft für Flugzieldarstellung mbH based on the military airfield Hohn in the north of Germany. The two-engined GFD-owned aircraft can be operated as Special Mission Aircraft with stores mounted under each wing carrying external loads of up to 450 kg on each side. Of interest is the calculation of the Takeoff Field Length (TOFL) of the GFD Learjets when operated with underwing stores on a wet or contaminated runway. The TOFL is by definition the greater of the Balanced Field Length (BFL) and 115% of the all-engines-operative takeoff distance. The BFL is determined by the condition that the distance to continue a takeoff following failure of an engine at some critical speed be equal to the distance required to abort it. It represents the worst case scenario, since failure at a lower speed requires less distance to abort, whilst failure at a higher speed requires less distance to continue the takeoff. V1 during takeoff is the maximum speed at which the pilot must take the first action (apply brakes) to stop the airplane within the accelerate-stop distance and the minimum speed at which the takeoff must be continued to achieve the required height above the takeoff surface within the takeoff distance.[1] The title of the project names specifically the BFL as it is usually the distance that determines the TOFL for aircraft with two engines.

Task

Set up a calculation / simulation based on the integration of the differential equation describing the aircraft motion under BFL conditions to output the BFL and V1. The calculation should be done for a set of specified input data. The simulation should be calibrated to performance data from the Aircraft Flight Manual (AFM). Detailed tasks are:

[1] The BFL concept was described from various sources as given in http://en.wikipedia.org/wiki/Balanced_field_takeoff

- Literature review and description of operational hazards during takeoff on wet and contaminated runways.
- Collection of all required geometrical and performance data of the Learjet 35A/36A.
- Detailed review of certification rules related to takeoff performance calculations.
- Derivation of equations required for the calculation / simulation of the BFL.
- Literature review and extraction of key equations for the calculation of drag on a rolling aircraft caused by a wet or contaminated runway (in contrast to a dry runway).
- Investigation of further details for the performance calculation of the Learjet 35A/36A: Aircraft drag polar, drag due to spoilers, lift decrease due to spoilers, thrust decay with speed and air density, idle thrust, brake coefficients, braking capabilities, ...
- Set up, description, calibration and verification of the calculation / simulation.
- Calculation of BFL and V1 for a set of specified input data.
- Comparison of calculation results with simpler approaches (BFL from **RAYMER 1989**; other TOFL estimation methods).

The report should be written in English based on German standards on report writing.

References

RAYMER 1989 **RAYMER**, D.P.: Aircraft Design: A Conceptual Approach, AIAA Education Series, Washington D.C. : AIAA, 1989