Project 7 – Longitudinal trim

Updated April 17, 2014

7.1 Context and objectives

The objective of this project is to explore the notion of aircraft longitudinal equilibrium and its role in aircraft operations.

You are about to fly a large transport aircraft across a continent and you are making preparatory calculations to determine whether it is safe to fly. The aircraft is already loaded with fuel; the passengers are boarding, and forty standard-size freight and luggage containers are about to be loaded in the lower sections of the fuselage.

Based on calculations as well as your best judgment,

- Determine the position and arrangement of containers that will result in the most economical cruise performance;
- Show that the aircraft can then be trimmed with zero elevator deflection in cruise;
- Determine a combination of tailplane and elevator angles that will allow you to control the attitude of the aircraft during final approach, when the flight will come to an end.

Your mark will be based on the clarity of your work and the validity of your calculations. You may use any tool you wish (e.g. software, books), but you are required to quote all of your sources.

Groups handing in written reports must hand in one single printed or PDF (A4-size) document, no longer than 8 pages.

Groups making an oral presentation must aim for less than 15 minutes (all members participating), and then answer questions from the class. Please hand in your slides as a print-out or PDF file.

7.2 Aircraft characteristics

- OWE: 174,3 t
- MTOW: 347 t
- MLW: 251 t
- Passengers: 302
- Fuel for the flight: 98,5 t

The center of gravity once the boarding and fueling are completed, immediately before the loading of the freight, is calculated to be 3,5 m ahead of the wing aerodynamic center.

7.3 Freight

Containers are all of standard LD3 size. Their length when slid in the aircraft is 2 m each.

- Passenger luggage: 14 containers wheiging 800 kg each
- Freight: 20 containers wheiging 800 kg each and 6 containers wheiging 1,2 t each

There are two 22 meter-long freight compartments, one ahead of the wing (root chord 10 m), and one behind.

7.4 Aerodynamic data

- Wing top-view surface: 350 m^2 clean, 370 m^2 with full flaps and slats.
- Horizontal tailplane surface: 64 m^2
- Mean aerodynamic chord: 4 m
- Distance between the wing and tailplane aerodynamic centers: 35 m
- The aerodynamic center is found 2,5 m behind the wing root leading edge
- Wing aerodynamic moment coefficient: −0,14 (clean wing); −0,24 (full flaps).

7.5 Limit values

- Maximum aircraft lift coefficient (full flaps): 2,7
- Aircraft attitude during flare (full flaps): 3°
- Maximum elevator deflection: 30°
- The tailplane characteristics are presented in figure 7.1 below.

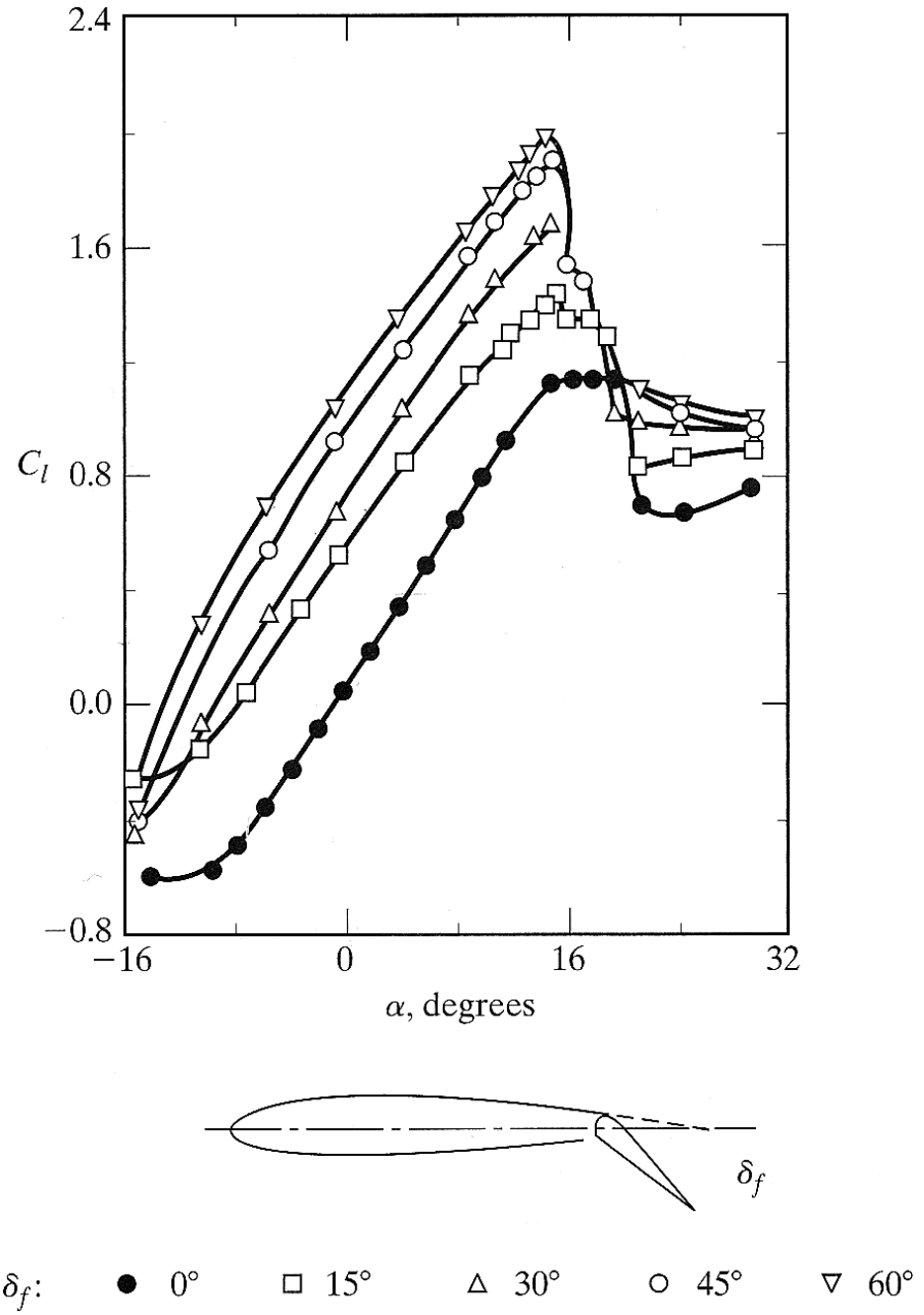

Figure 7.1: Wind tunnel data for the tailplane lift coefficient