A JAVA-BASED FRAMEWORK FOR AIRCRAFT PRELIMINARY DESIGN
WING AERODYNAMIC ANALYSIS MODULE, LONGITUDINAL STATIC STABILITY AND CONTROL MODULE

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Abstract

The purpose of this work is the development of ADOpT (Aircraft Design and Optimization Tool) and its reference library JPAD, a java-based framework, completely written in Java, conceived as a fast and efficient tool useful as support in the preliminary design phases of an aircraft, and during its optimization process.
The principal focus of the library is the overall aircraft model, conceived as a set of interconnected and parametrized sub-models: the wing and its variants (horizontal tail, vertical tail), the fuselage, nacelles, the propulsion system.The aim of this work is to create and to make operative the modules for the analysis of Lift, Drag and for Longitudinal Static Stability on an aircraft including the non-linear effects. The input parameters are passed to the software as XML files divided for components.With the developed modules it is possible to execute an aerodynamic analysis on an isolated wing or on an aircraft drawing the complete curve of C_L vs alpha and evaluating the $C_{L\ max}$ using the stall path. It is also possible to evaluate the fuselage effects on wing lift and draw the lift curve with high lift devices. The downwash gradient and the angle of downwash have been evaluated considering the variable distances between the horizontal tail and the vortex plane. In this way the downwash calculation turns out to be more accurate.

Station	Airfoil	Reynolds Number	CL_{max}
Root	NACA 23018	$6.28 \cdot 10^6$	1.65
Kink	NACA 23018	$6.28 \cdot 10^6$	1.65
Tip	NACA 23015	$4.41 \cdot 10^6$	1.7

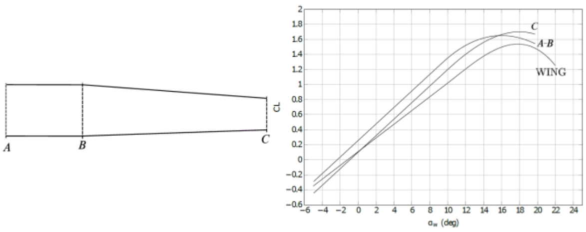


Figure 1 – 2D and 3D lift results for regional turboprop. M=0.2.

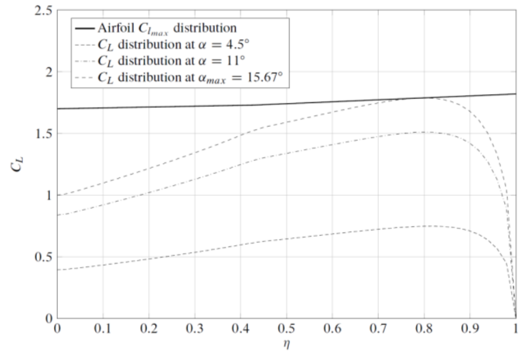
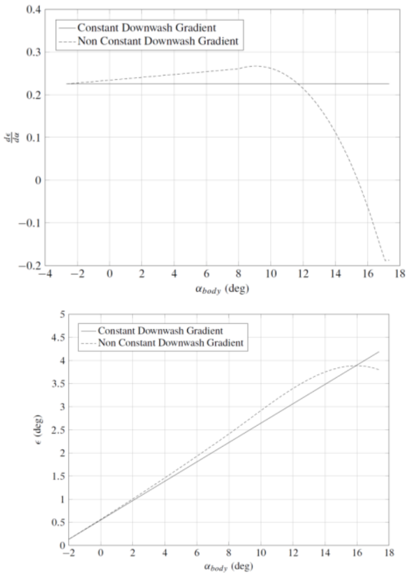


Figure 2 – Stall Path. Transport jet M=0.8.



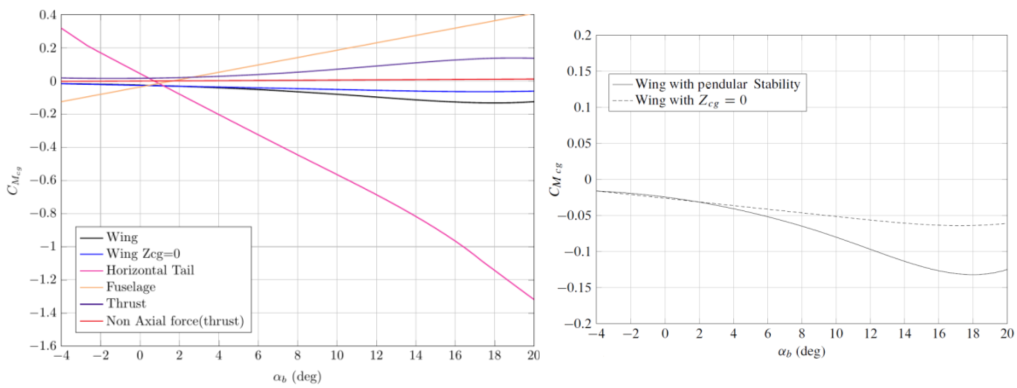


Figure 4 – C_M respect to CG vs α_b of aircraft components. Comparison with and whitout pendular stability

Figure 3- Variability of downwash angle and downwash gradient. Regional turboprop, M=0.4.