

Flow Visualization of Wing Vortices of Delta Wings

Philipp Epple^{1*}, Dustyn Kramer¹, Michael Steppert¹

¹ Coburg University of Applied Sciences
Department of Mechanical Engineering
Coburg, Germany

*Corresponding author: philipp.epple@hs-coburg.de

Introduction

Delta wings are optimized to operate at supersonic speeds. Since delta wings are very thin, they do not generate lift at low subsonic speeds as usual wings do. At low velocities two strong vortices are created over the wing generating substantial lift to allow aircraft with delta wings to take off and land at low subsonic velocities, e.g. [1]. Delta wings differ in shape depending on the design Mach number.

Description of the flow visualization method

A delta wing model was 3D printed with a Fused Deposition Modeling (FDM) printer, the material used was PLA plastic (polylactic acid). For the flow visualization, smoke was released into the flow in front of the delta wing and two laser sheets were used to visualize the cross section of the two delta vortices at two positions of the delta wing, Fig. 1. In a second experiment the smoke was released in front of the model through a multiple whole vertical nozzle generating the streamlines, Fig. 2. This nozzle was also 3D printed with FDM. The flow visualization was performed in a low-speed wind tunnel at 20 m/s at high angles of attack, between 10° and 30°.

Physical insight and conclusions

The flow visualization experiments showed clearly that two vortices form at the top of a delta wing at low subsonic velocities and high angles of attack. These vortices form from the tip to the trailing edge of the delta wing and are stable. In Fig. 2 it can also be seen that the vortices remain stable also after the trailing edge of the delta wing. These vortices are crucial for takeoff and landing of supersonic aircraft with delta wings.

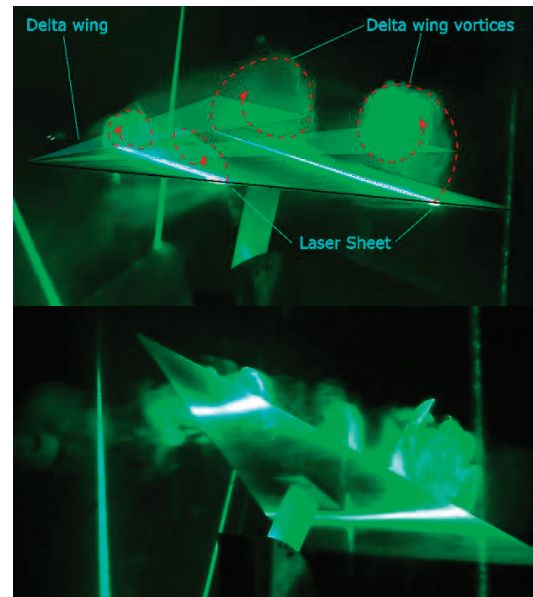


Figure 1: Delta wing vortices, top and bottom view

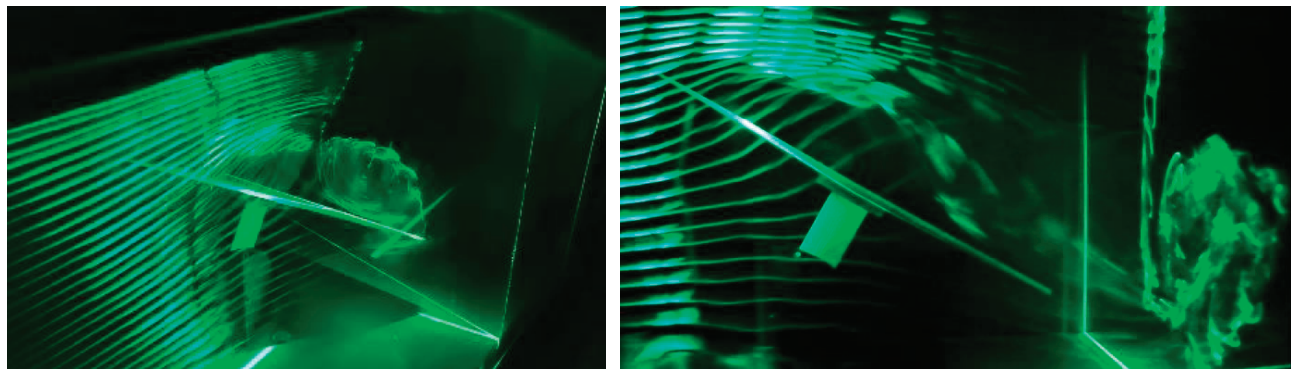


Figure 2: Flow visualization of streamlines around a delta wing showing the structure of one of the delta wing vortices

References

- [1] Houghton, E.L., Carpenter, P.W., Collicott, S.H., Valentine, D.: Aerodynamics for Engineering Students, 6th Edition, Butterworth-Heinemann, Oxford, 2013.