

Indian Institute Of Technology Kanpur

AE 351A
Experiments in Aerospace Engineering 2020-21
Semester II

Experiment 5C

3-D Flow visualization over a Delta Wing

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1. Objective

Observe the vortex pair formed on top of the delta wing, and study their breakdown.

2. Introduction And Theory

When a slender delta wing with a sharp leading edge is at a moderate angle of attack, a vortex pair is generated on top of the delta wing. This happens due to the separation of the flow along the leading edge of the delta wing forming a separated shear layer. This shear layer rolls up to form a counter rotating vortex pair which move past the top surface of the wing. The formation of these vortices delays the stall which happens at relatively high angle.

3. Equipment's

- Low speed wind tunnel
- Delta wing (model)
- Laser
- Smoke Generator

4. Pcedure and Measurement

- Mounted the delta wing for flow visualization in the test section.
- Started the tunnel, smoke generator and laser for illumination. Observed the vortices formed at different angle of attack.

The specifications of the low speed wind tunnel are:

Sl. No.	Property	Measurement
1	Type	Open – Return Suction Type
2	No. Of Screenings in the settling chamber	6
3	Contraction ratio	16:1
4	Test section dimensions	0.6 m X 0.6 m X 3 m
5	Max. Velocity	~ 25 m/s
6	Motor	20 Hp AC

5. Observation

Vortices Pair on a delta wing at some angle of attack at various location on wing from upstream to downstream.

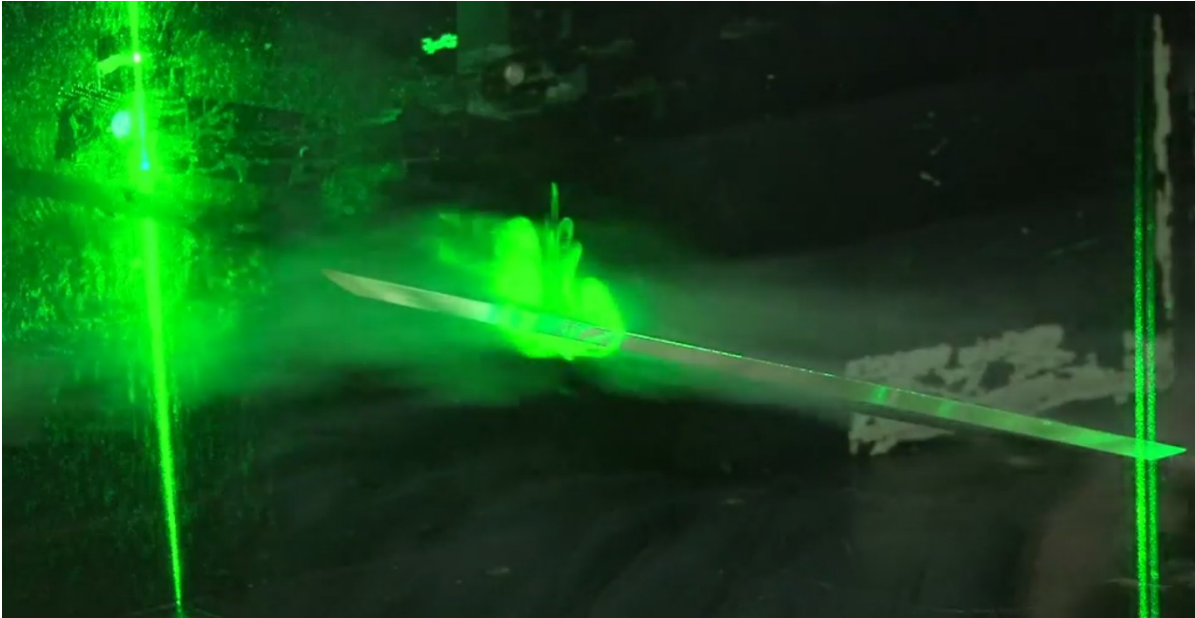


Figure 1: Vortices at near leading edge



Figure 2: vortices at middle of the wing



Figure 3

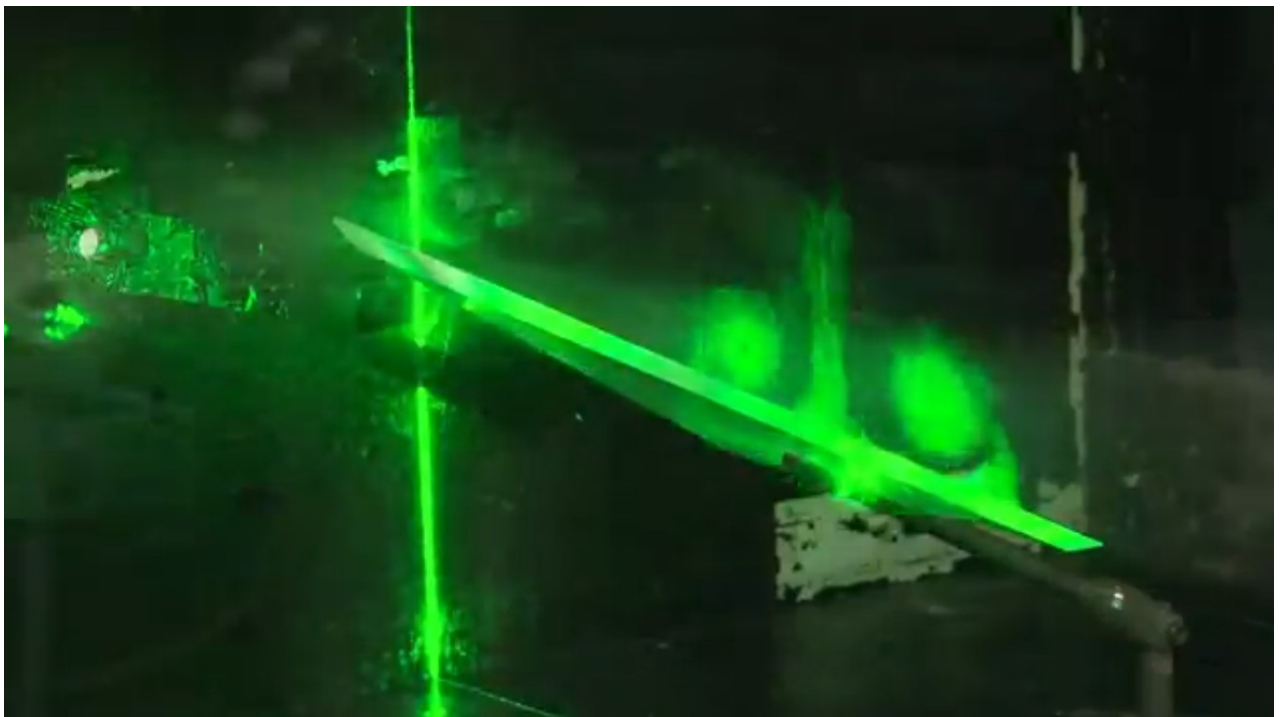


Figure 4: Vortices Breakdown

Delta wing Rocking when Increase velocity

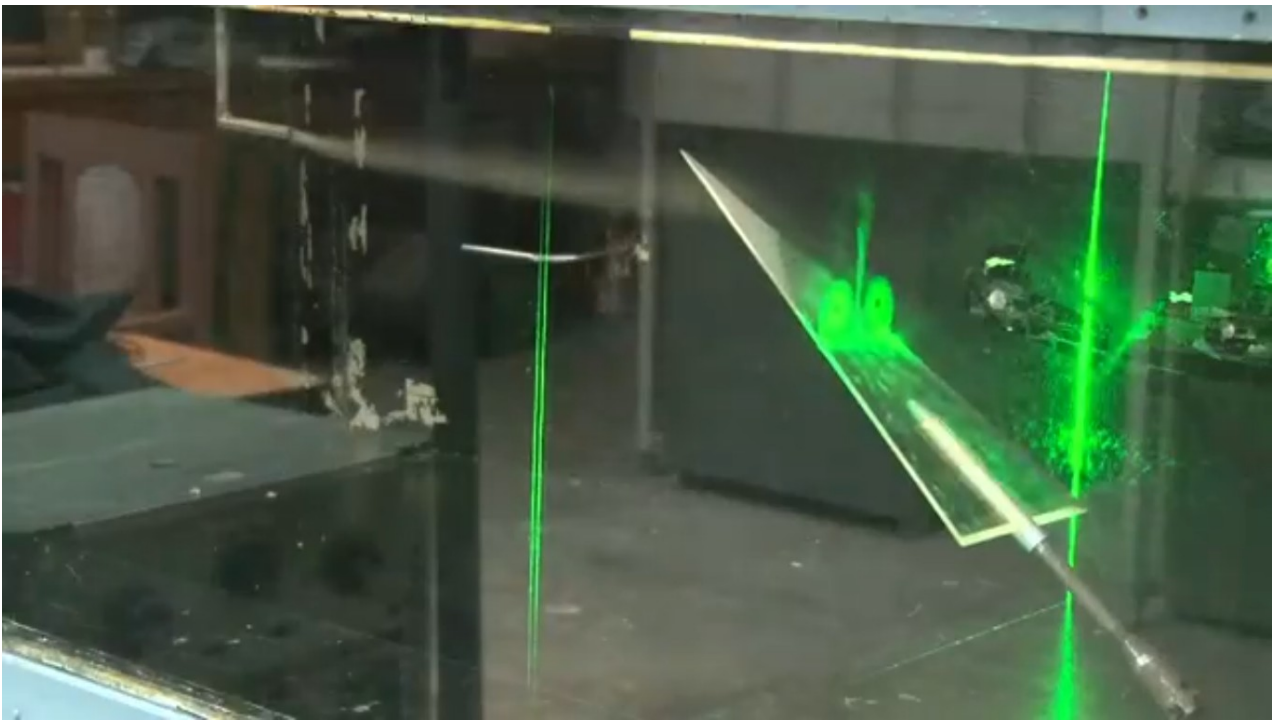


Figure 5



Figure 6: Wing Rocking

6. Results

- Sharp leading-edge configurations are often used in delta wing because primary separation is fixed and leading-edge vortex evolution is less sensitive to Reynolds number effects.
- Angle of attack is the main parameter for the sharp leading-edge .
- Vortex breakdown is caused by the stagnation of the low-energy axial core flow due to the increase of the adverse pressure gradient along the vortex axis with increasing angle of attack.
- The vortices on delta wing useful to military aircraft to do maneuvering.
- Increasing AOA and velocity, lead to **wing rocking** – vortex of one side increases and other side decreases that make wing to oscillate.

7. Precautions

- Follow the safety instructions while running the laser.
- Do not stand in the laser light path.
- Make sure that the laser light reflected back from the wing surface do not hit any person visualizing the flow.
- Always turn off the tunnel before opening the test section for model removal or mounting.
- Keep the room well ventilated while running the smoke-generator.