Module #7 - Wing and High Lift Device Testing

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I. OVERVIEW

What is a wing on an aircraft? What are the different high lift devices?

A wing is a type of fin that produces lift, while moving through air or some other fluid. As such, wings have streamlined cross-sections that are subject to aerodynamic forces and act as airfoils. A wing's aerodynamic efficiency is expressed as its lift-to-drag ratio.

High Lift Devices In aircraft design, high-lift devices are moving surfaces or stationary components intended to increase lift during certain flight conditions. Most jet transport aircraft are fitted with high lift devices on both leading and trailing edges which increase the lift coefficients to enable the aircraft to generate large amounts of lift at low speed for take-off and landing. Smaller aircraft are usually just fitted with trailing edge flaps. Aircraft are fitted with high lift devices to reduce the take-off and landing distances.

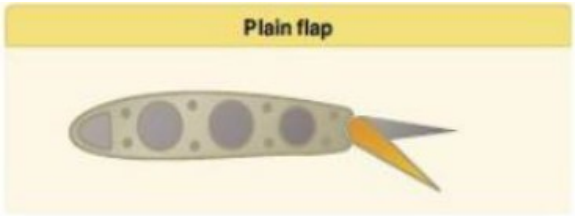
II. LEARNING OUTCOMES

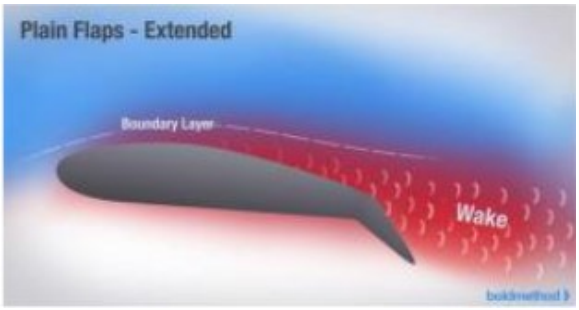
➢ Determine the effects of high lift devices on the wings of an aircraft

➢ Understand the theory behind how an aircraft generate lift.

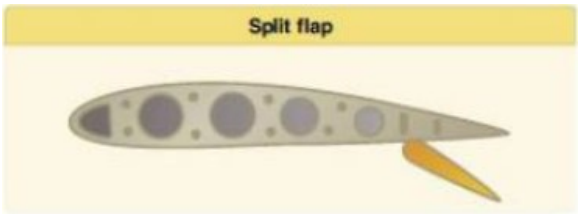
III. DISCUSSION

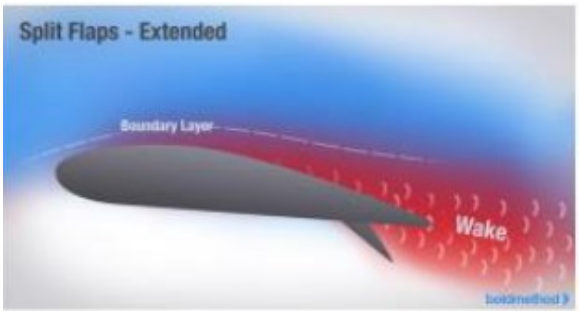
Flaps Plain Flaps - The plain flap is the simplest. It increases the airfoil camber, resulting in a significant increase in the coefficient of lift (CL) at a given AOA. Plain flap increases the lift by approximately 55 %.



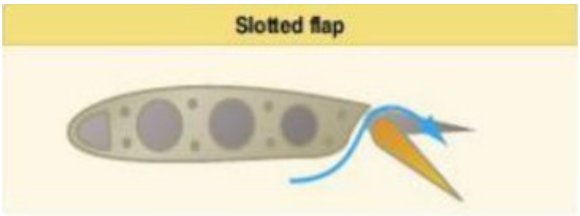


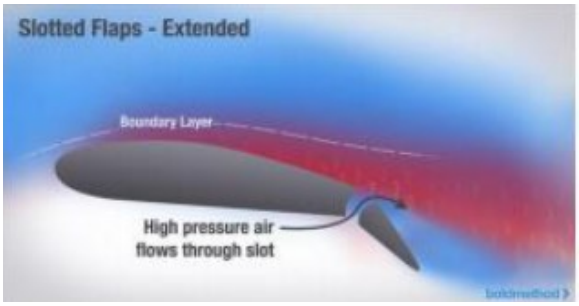
Split Flaps - The split flap is deflected from the lower surface of the airfoil and produces a slightly greater increase in lift than the plain flap. The drag however is higher than for the plain flap. Split edge flap increases the lift by approximately 65%.



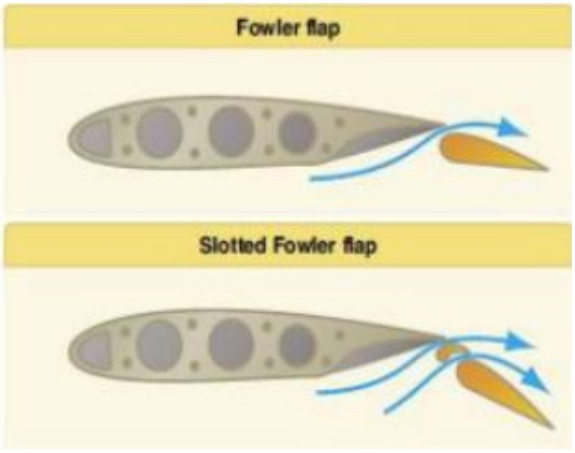


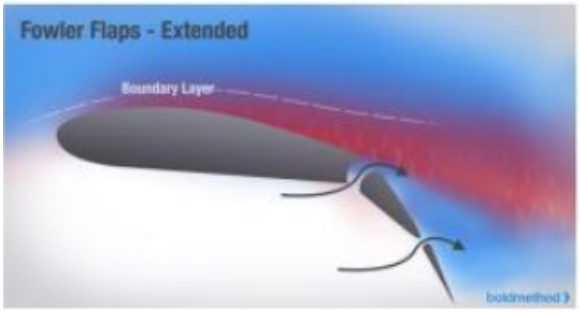
Slotted Flaps - Slotted flaps increase the lift coefficient significantly more than plain or split flaps. When the slotted flap is lowered, high energy air from the lower surface is ducted to the flap's upper surface. Slotted flap increases the lift by approximately 70%.





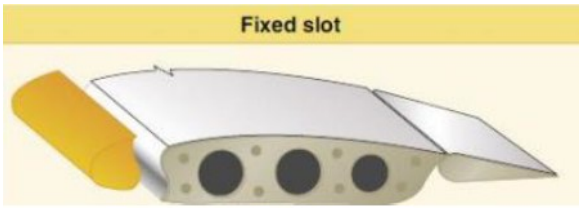
Fowler Flaps - Fowler flaps are a type of slotted flap. This flap design not only changes the camber of the wing, it also increases the wing area. The fowler flap rolls back on a track when it is extended. This increases the effective area of the wing and also lowers the trailing edge. Fowler flap increases the lift by approximately 90 %.



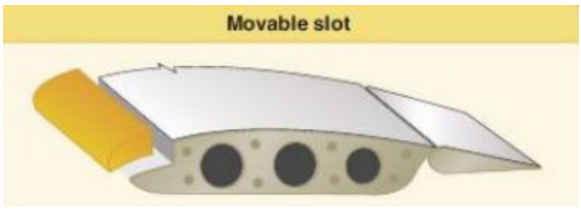


The slat or slot may be either full span, or may occur on only part of the wing (usually outboard), depending on how the lift characteristics need to be modified for good low speed control.

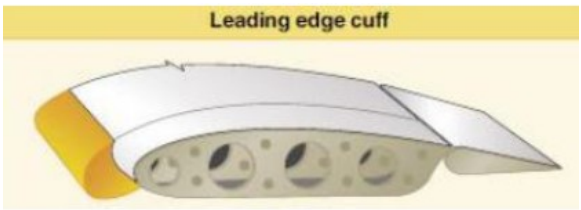
Fixed slots - Fixed slots direct airflow to the upper wing surface and delay airflow separation at higher angles of attack. The slot does not increase the wing camber, but allows a higher maximum CL because the stall is delayed until the wing reaches a greater AOA.



Movable slots - Movable slats consist of leading-edge segments, which move on tracks. At low angles of attack, each slat is held flush against the wing's leading edge by the high pressure that forms at the wing's leading edge.

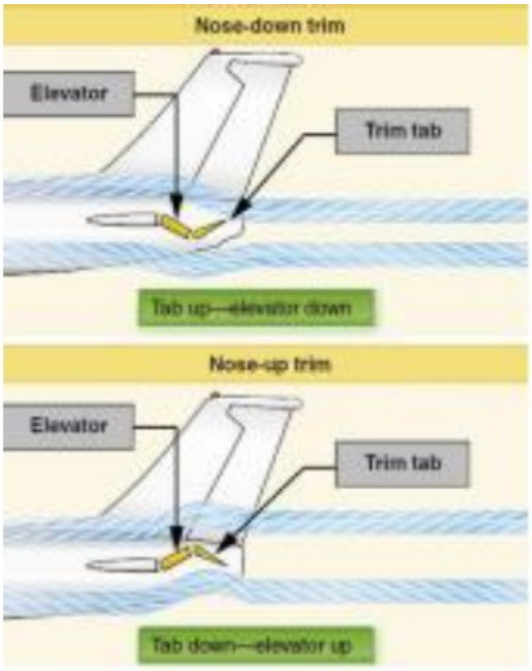


Leading Edge flaps - Leading edge flaps, like trailing edge flaps, are used to increase both CL-MAX and the camber of the wings. A small increment of leading-edge flaps increases lift to a much greater extent than drag.

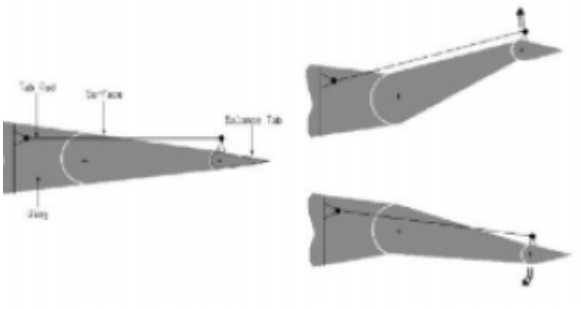


Spoilers - are deployed from the wings to spoil the smooth airflow, reducing lift and increasing drag.

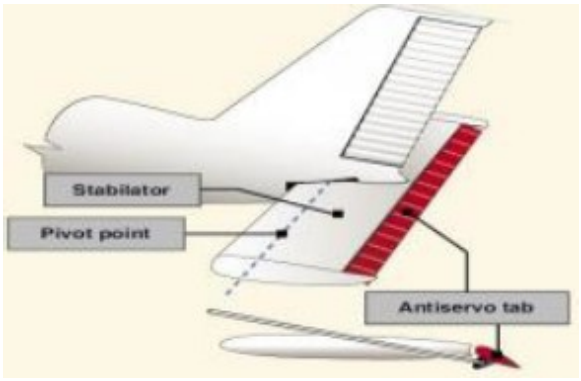
Trim System - An airplane is trimmed when it will maintain its attitude and speed without the pilot having to apply any load to the cockpit controls. Trim Tabs - most common installation on small aircraft is a single trim tab attached to the trailing edge of the elevator. Most trim tabs are manually operated by a small, vertically mounted control wheel. The movement of the elevator is opposite to the direction of movement of the elevator trim tab.



Balance Tabs - the control forces may be excessively high in some aircraft, and, in order to decrease them, the manufacturer may use balance tabs. They look like trim tabs and are hinged in approximately the same places as trim tabs. The disadvantage of the balance tab is that it reduces the efficiency of the control surface.



Antiservo Tabs -attempts to streamline the control surface and is used to make the stabilator less sensitive by opposing the force exerted by the pilot.



Ground Adjustable Tabs - This tab is bent in one direction or the other while on the ground to apply a trim force to the rudder. The correct displacement is determined by trial and error.

With the addition of high lift devices, the conducted activity seeks to differentiate the results of a clean wing and a wing with deployed high lift devices.

Conclusion:

Testing the design high lift devices on the wind tunnel can help designers/students to understand different effects of airflow on different high lift devices. We all know that it is better to have a maximum high lift force than drag force when it comes to aviation. The incorporation of high lift devices allows aircraft designers to reduce the overall size and surface area of the wing reducing its drag thus making the aircraft more fuel efficient during the cruise phase of flight.