38

TITLE

Zlin Z 42 Airfoil

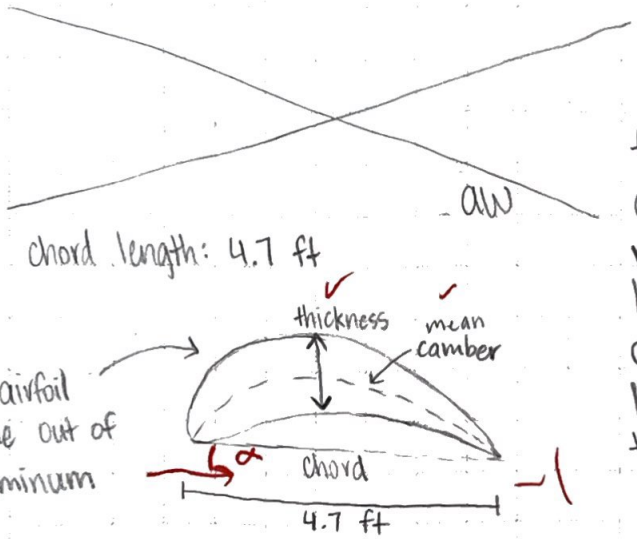
10/27/22

Design Brief:

We are going to design an airfoil shape for a Zlin Z 42 plane that generates more lift, and fits for a 1,322 lb plane, with a 124 mph cruising speed, a cruising altitude at 1,969 ft, a wing area of 135 ft², and a wing span of 29 ft, 11 in. The airfoil will be no larger than 135 ft,² it will be constructed out of aluminium just as the original airfoil. This project will be completed by Friday, November 4, 2022.

Initial Sketch:

10/28/22



function: The airfoil will create more lift for the plane because it has a larger thickness, and larger camber which makes for a larger vertical component that will make more lift.

Math: N/A

Simulation Notes:

- lift = 2,911 lbs, drag = 250 lbs for original airfoil $\frac{L}{D} = \boxed{11.6}$
- we changed angle of attack to 4°, changed lift to 2,352 lbs, drag = 193 lbs
- changed camber to -2%, changed lift = 1,181 lbs, drag = 134 lbs
- increased thickness to 14%, lift = 1,223 lbs, drag = 153 lbs
- 10/31/22 increased thickness to 19%, lift = 1,326 lbs, drag = 174 lbs $\frac{L}{D} = 7.6$
- decreased thickness to 6%, increased angle to 5°, lift = 1,610, drag = 185 $\frac{L}{D} = 8.7$
- angle: -6°, camber = 11, thickness = 20%, lift = 2,648, drag = 398 $\frac{L}{D} = 6.7$
- our $\frac{L}{D}$ ratio is too low, it needs to be greater than 11.6
- angle: -4°, camber = 7, thickness = 19%, lift = 1,644, drag = 208 $\frac{L}{D} = 7.9$ ✓
- angle: -2°, camber = 5, thickness = 12%, lift = 1,827, drag = 119 $\frac{L}{D} = 15.4$
- the $\frac{L}{D}$ ratio is high enough, but we need less lift
- angle: -3°, camber = 5, thickness = 12%, lift = 1,244, drag = 84 $\frac{L}{D} = 14.8$
- angle: -3°, camber = 5, thickness = 10%, lift = 1,283, drag = 67 $\frac{L}{D} = 19.1$
- the lift is only 39 lbs away and the ratio is 7.5 higher than the original

DESIGNED BY: Audrey Wiele

DATE: 10/31/2022

WITNESSED BY: Jacob Beltran

DATE: 10/31/2022

Zlin Z 42 Airfoil (2)

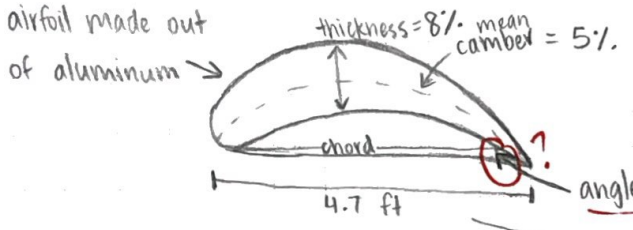
Simulation Notes:

- angle: -3°, camber: 5%, thickness: 8%, lift: 1,322, drag: 89. $\frac{L}{D}$ = 14.9
- the $\frac{L}{D}$ ratio decreased, but the lift is the exact same as the weight of our plane

11/2/22

Final Sketch:

airfoil lift = 1,322 drag = 89



11/4/22

function: The airfoil has more lift than the original plane because it has a larger thickness and larger camber which makes for a larger vertical component, creating more lift.

$\frac{L}{D}$ ratio = $\frac{1,322}{89}$ = 14.9

aw

Conclusion:

We designed an airfoil for a Zlin Z 42 plane that provided more lift with a higher lift to drag ratio. The lift was 1,322 lbs and our $\frac{L}{D}$ ratio ended up being 14.9, compared to the original lift of 2,911 lbs and $\frac{L}{D}$ ratio of 11.6. Our first design had an angle of attack of 4° and the lift was 2,352 lbs, which is too much for the plane that weighed 1,322 lbs. We made several changes to decrease the lift and get it as close to our plane weight as possible. We changed the angle of attack to negative degrees because when the airfoil has a lower angle, the air flows at a smaller angle and straighter off the wing compared to the normal downward direction. This decreases the upward vertical force which also decreases lift. Another major change we made to the airfoil was decreasing the thickness. This also affects how the air flows over the wing, and makes the air flow more linear than downward off the wing. This decreases the vertical force and the lift. Our airfoil ended up with a -3° angle of attack, a 5% camber, and 8% thickness. If we had more time, we would try to decrease our drag more while still keeping the lift at the weight of the plane. We could decrease the thickness and record tests at decimals such as 7.9% and 8.1% to see the effect it would have on the lift of the plane. We could also see if we could keep the original airfoil shape of the plane, but have a better $\frac{L}{D}$ ratio and keep the lift the same as the weight.