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ME 572 – Aerodynamic Design

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HW #7

The Delta Wing

The delta wing is a type of wing planform designed for high-speed flows, such as subsonic flow. How did this planform come into fruition? It first appeared in 1529 on rockets which used this kind of triangular shape as stabilizing fins. However, it was officially used (and patented) on planes by J.W. Butler and E. Edwards in 1867. They designed the delta shape for a rocket propelled plane, which would allow for a low aspect ratio wing. This was only an early patent, and a more practical design for the delta wing was first developed in the 1930s by Alexander Lippisch. This type of iteration had no tail, which meant that the wing had a root chord reaching almost to the end of the plane's fuselage. The first delta wing plane flew in 1931. Famous aircraft that utilized the delta wing include the Concorde and the Space Shuttle.

The design of the delta wing is most prominently recognized as a triangular shape, with a long root chord tapering into a small tip chord. Since there is more volume and structure closer to the fuselage, the delta wing is naturally strong compared to lower aspect ratio wings (low aspect ratio wings have material distributed further away from the fuselage). The high sweep angle is also a design principle of the delta wing, as it is how it achieves such a high aspect ratio. This type of high root chord structure also allows more space and fuel storage in the fuselage. The delta wing is also easy to manufacture because of its simple triangular shape and sharing similar methods to that of regular tapered wing.

The delta wing offers incredible performance when flying at subsonic speeds. The shape of the wing allows for two vortex patterns to form over the edge of the wing. With this, the pressure difference increases tremendously, which leads to enhanced lift. It is also extremely maneuverable in roll and pitch. Since the sharp leading edge allows air to follow the contour, at subsonic speeds the delta wing can control air better. Closer to the root of the wing, the airflow is still attached. This overall gives it a high lift to drag ratio, which allows for subsonic speeds to be easily achievable. Additionally, it has high angle of attack capability because of the vortex producing wing leading edge and tip.

At low speeds, the delta wing relies on high angles of attack to maintain lift, but because of the high sweep angle, the flow around the leading edge creates vortices that accelerates airflow and maintains lift. However, this increases the drag since flow is being separated. The high wing area also increases viscous drag. At high speeds reaching the subsonic region, the delta wing performs like a swept wing, where lift is high about the leading edge. In the transonic region, delta wings reduce the effects of compressible flow such as shock formation.

References

- [Delta wing - Wikipedia](#)
- [Delta Wings \(centennialofflight.net\)](#)