Lifting Surface Sweep Angle (Swp)

In selecting the lifting surface sweep angle the designer must give considerations to several general requirements. These requirements are related to:

1. Aerodynamics
2. Structural weight
3. Balance & Stability

Introduction

Wing sweep is mainly used to reduce the negative effects of transonic and supersonic flow. The speed of the air passing on the upper surface of wing is increased. The critical Mach number is the speed at which the local flow on the upper surface reaches the speed of sound. If the speed continues to increase, a shock wave will appear and the drag will drastically increase.

Straight | Swept | Forward swept | Variable sweep | Oblique wing

High speed aerodynamics

Sweep angle (↗) is favorable for high speed flight to delay the apparition of wave drag. Shock formation on a swept wing is determined by the air velocity in a direction perpendicular to the leading edge of the wing.

Structural weight

Sweep angle as low as possible (↘) to reduce the structural weight of the lifting surface

$$W_w = \mathrm{fct}\left(\cos(\Lambda)^{-0,9}\right)$$

Λ	ΔW_w
0°	0,0%
10°	1,4%
20°	5,8%
30°	13,8%

Balance & Stability

Sweep Angle (↗,↘) is necessary to balance the aircraft in order to move the Aerodynamic Center (AC) far enough from the CG position for balance.

Sweep angle (↗) improves stability. A swept wing has a natural dihedral effect (rolling moment caused by sideslip). Good to know that about 10° of sweep provides about 1° of effective dihedral.

If an aircraft has its vertical tails at the wing tip position, sweeping the wing (↗) will move the tails aft, increasing their efficiency.

References

Aircraft Design: A Conceptual Approach, Third Edition, Daniel P.Raymer

Wikipedia. http://en.wikipedia.org/wiki/Wing_configuration

