Lift slope - lift gradient

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Lift slope is a term widely used in aerodynamics to quantify the lift suitability of a wing, surface or body.

Other name: "'lift gradient'"; in English "lift slope" or "lift gradient".

This lift is exerted upwards (z) or sideways (y).

Lifto Slope

The lift slope is the slope of the line that describes the relationship between the lift coefficient (Cz) and the incidence of the wing (?).

The angle of incidence is the angle between the reference chord of a profile and the direction of the airflow;

the Cz has no unity; The incidence is expressed in degrees or radians.example: a profile that requires 12 degrees of incidence to have a Cz = 1 has a lift slope:dCz/d? (or Cz?) = 1 / 12 = 0.0833in English: dCL/d? or CL?
The lift slope depends mainly on the aspect ratio (but also on the deflection angle of the wing and the Mach number).

The theoretical maximum (for a wing of infinite aspect ratio) is 2? = 6.28 (with ? in radians) or ?²/90 = 0.1096 (with ? in degrees).

Lift angle

It is the inverse of the lift slope:

For a finite elongation, we can calculate this angle with the following approximate formula, valid at the usual elongations (4<?<20):d?/dCz = 10 + 19 / ?, with ? = effective aspect ratio of the wing, or, more precisely, for low aspect ratios:d?/dCz = 10 + 19 / ? + 9 / ?^2
Application:

i.e. a wing of aspect ratio 6

d?/dCz = 10 + 19 / 6 = 13.2this incidence (counted from the zero lift incidence) is needed to have Cz = 1this wing has a

"lift slope" $dCz/d\alpha$ = 1 / 13.2 = 0.076 in Cz/deg or 4.35 in Cz/rad

or a wing with an aspect ratio of 1.55 (delta wing, Concorde)

$d\alpha/dCz$ = 10 + 19 / 1.55 = about 22.2 (the formula used being less accurate at small elongations)this incidence (counted from the incidence of zero lift) would be needed to have Cz = 1on this aircraft the incidence is limited to 19°, which gives a maximum Cz of 19 / 22.2 = about 0.85

Lateral Lift

Concerns the lateral lift of a tapered body or a vertical surface, a daggerboard for example.

It is the slope of the line that defines the relationship between the lateral lift coefficient of the body (Cy) and the skid angle (β).

Sources

Fluid Dynamic Lift, Hoerner