DEPARTMENT OF AUTOMOTIVE AND AERONAUTICAL ENGINEERING

The Blaine Rawdon Factor in Aircraft Design

Task for a Master Thesis.

Background

The Blaine Rawdon Factor (BRF)

$$B = \frac{\gamma \cdot l_v}{C_L \cdot b}$$

with l_v: vertical tail lever arm, γ: diheral angle, b: wing span, C_L: lift coefficient of the aircraft. B elucidates whether an aircraft is spirally stable, neutral, or unstable.

- $B > 5$ spirally stable.
- $B = 5$ spirally neutral.
- $B < 5$ spirally unstable.

As elaborated by Mark Drela[1] (MIT), for an aircraft equipped with ailerons, B ideally falls between 2.0 and 5.0, with a preference towards at least 3.0. Surjeet Yadav[2] further explains that while spiral stability isn't an absolute necessity, most aircraft, particularly Radio Controlled (RC) planes, tend to be spirally unstable. However, to ensure stable flight, pilots or autopilot systems compensate for this instability. Yadav suggests a value of $B = 5.5$ or similar for designing a spirally stable aircraft. The equation from above can then be used to calculate the dihedral angle.

Task

The task is to investigate the BRF as an equation to predict spiral stability or to calculate a dihedral angle. These steps should be followed:

- Explore the originator of the equation, Blaine Rawdon,[3] and provide the historical context.
- Apply the BRF across a range of passenger aircraft, considering various design parameters such as dihedral/anhedral angle, wing sweep, size of the vertical tail, and wing configuration (high/low).

[1] https://www.rcsoaringdigest.com/pdfs/RCSD-2004/RCSD-2004-08.pdf
[2] https://surjeetyadav.wordpress.com/2014/01/22/74
[3] https://www.linkedin.com/in/blaine-rawdon-57771587,
http://goldfinger.utias.utoronto.ca/IWACC5/IWACC7/Page.pdf
https://ocw.mit.edu/courses/16-886-air-transportation-systems-architecting-spring-2004/afc7cd4280edbdfa91fd92907b6ec4e0_h07bkresumfornsf.pdf

- Look at my Lecture Notes[4] in Flight Mechanics 2[5] and in particular at the Slides, Ch. 3, p. 23. Consider the spiral mode (and roll subsidence) transfer function approximation, Δ_{SR}. Calculate the roots of the polynomial, comment on the stability of the mode(s). To do so, find values for the stability derivatives for some aircraft.
- Show that a large tail can make an aircraft spirally unstable but is needed for Dutch Roll damping.
- Ultimately, formulate simplified design rules for lateral dynamic stability, encompassing various aircraft parameters and design considerations.

The report must be written in English based on German or international standards on report writing.

[4] https://www.fzt.haw-hamburg.de/pers/Scholz/materialFM2s/Skript.html
[5] https://www.fzt.haw-hamburg.de/pers/Scholz/Flugmechanik2E.html