

Glide Ratios



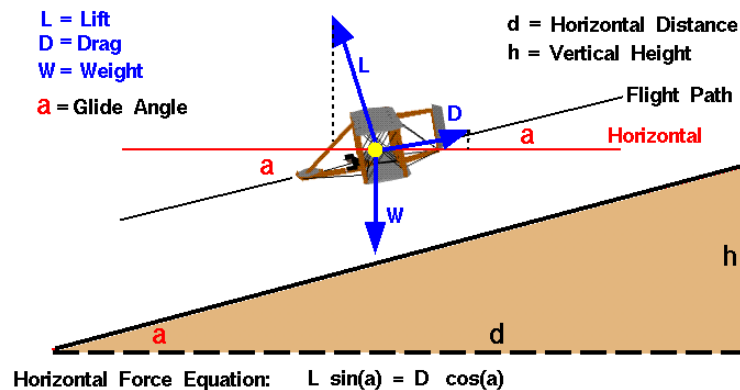
Otto Lilienthal in mid-flight, c. 1895;
http://en.wikipedia.org/wiki/Otto_Lilienthal

Two different gliders start from the same height. Which glider goes farther: one with a glide ratio of 185:25 or one with a glide ratio of 155:20? Explain your reasoning. *



Lift to Drag Ratio (L/D Ratio)

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$$\text{ratio} = \frac{\text{Lift}}{\text{Drag}} = \frac{L}{D} = \frac{cl}{cd} = \frac{1}{\tan(a)} = \frac{d}{h} = \frac{\text{distance}}{\text{height}}$$

NASA Glenn Research Center, *A Beginner's Guide to Aerodynamics, Aircraft Forces, Lift to Drag Ratio*

<https://www.grc.nasa.gov/www/K-12/airplane/ldrat.htm>

Lift-to-drag ratio

In aerodynamics, the **lift-to-drag ratio**, or **L/D ratio**, is the amount of lift generated by a wing or vehicle, divided by the drag it creates by moving through the air. A higher or more favorable L/D ratio is typically one of the major goals in aircraft design; since a particular aircraft's required lift is set by its weight, delivering that lift with lower drag leads directly to better fuel economy, climb performance, and glide ratio.

The term is calculated for any particular airspeed by measuring the lift generated, then dividing by the drag at that speed. These vary with speed, so the results are typically plotted on a 2D graph. In almost all cases the graph forms a U-shape, due to the two main components of drag.

Lift-to-drag ratios can be determined by flight test, by calculation or by testing in a wind tunnel.

Glide ratio

As the aircraft fuselage and control surfaces will also add drag and possibly some lift, it is fair to consider the L/D of the aircraft as a whole. As it turns out, the glide ratio, which is the ratio of an (unpowered) aircraft's forward motion to its descent, is (when flown at constant speed) numerically equal to the aircraft's L/D. This is especially of interest in the design and operation of high performance sailplanes, which can have glide ratios approaching 60 to 1 (60 units of distance forward for each unit of descent) in the best cases, but with 30:1 being considered good performance for general recreational use. Achieving a glider's best L/D in practice requires precise control of airspeed and smooth and restrained operation of the controls to reduce drag from deflected control surfaces. In zero wind conditions, L/D will equal distance traveled divided by altitude lost.

Achieving the maximum distance for altitude lost in wind conditions requires further modification of the best airspeed, as does alternating cruising and thermaling. To achieve high speed across country, glider pilots anticipating strong thermals often load their gliders (sailplanes) with water ballast: the increased wing loading means optimum glide ratio at higher airspeed, but at the cost of climbing more slowly in thermals. As noted below, the maximum L/D is not dependent on weight or wing loading, but with higher wing loading the maximum L/D occurs at a faster airspeed. Also, the faster airspeed means the aircraft will fly at higher Reynolds number and this will usually bring about a lower zero-lift drag coefficient.

http://en.wikipedia.org/wiki/Lift-to-drag_ratio#Glide_ratio

Examples

Flight article	Scenario	L/D ratio
Virgin Atlantic GlobalFlyer	Cruise	37
Rutan Voyager	Cruise	27
Lockheed U-2	Cruise	25.6
Albatross		20
Boeing 747	Cruise	17.7
Common Tern		12
Herring gull		10
Wright Flyer		8.3
Concorde	Mach 2	7.5
Helicopter	100 knots	4.5
Concorde	T/O, land	4
House Sparrow		4

Flight article	Scenario	Glide ratio L/D ratio
Modern Sailplane	Gliding	40-60
Hang glider		15
Gimli Glider	Boeing 767	~12
Paraglider	High Performance model	11
Helicopter	Autorotation	4
Powered parachute	Rectangular/elliptical parachute	3.6/5.6
Space Shuttle	Approach	4.5
Wingsuit	Gliding	2.5
Northern flying squirrel	Gliding	1.98
Space Shuttle	Hypersonic	1
Apollo CM	Reentry	0.368

In gliding flight, the L/D ratios are equal to the glide ratio (when flown at constant speed).

http://en.wikipedia.org/wiki/Lift-to-drag_ratio#Glide_ratio