

Dihedral: Why Your Wings Have An Upward Angle

By Colin Cutler | 04/11/2023 | [Previous](#) | [Next](#)



Dihedral is the upward angle of the wings (or tail surface) from a horizontal axis. Dihedral makes aircraft more laterally stable, which means they are more stable when they roll left or right.

Dihedral is found on just about every aircraft. In the picture below, you can see an example of wing dihedral on our Cirrus, and you'll see the same thing if you look directly at a Cessna 172.



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Here's an example of wing dihedral on a Boeing 777:

Dihedral = Upward Angle Of Wings

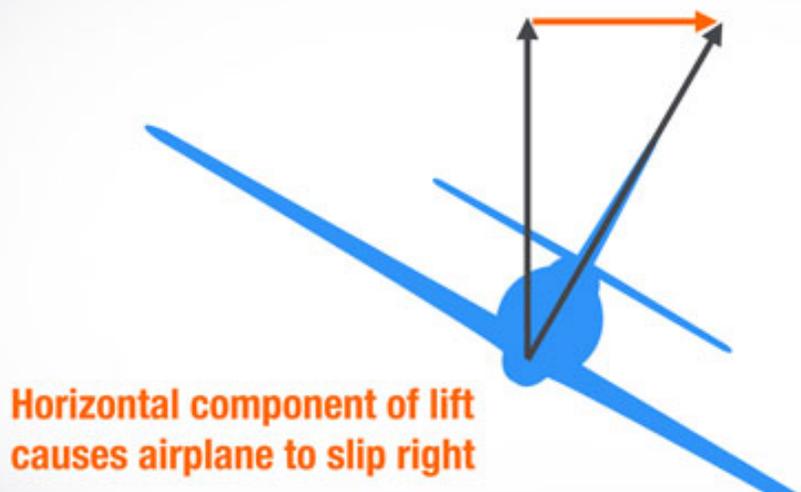


Aleksandr Markin

Why Do You Need Dihedral?

It all comes down to stability. If you didn't have dihedral, you'd spend more time keeping your wings level. Here's why:

Aircraft Without Dihedral Won't Naturally Return To Wings-Level



When you bank an airplane, the lift vector tilts in the same direction as the bank. And when that happens, your airplane starts slipping in the same direction, in this case, to the right.

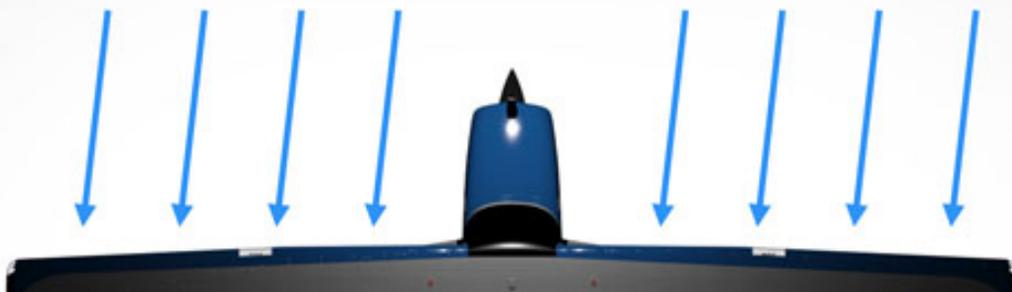
The problem is, if you have a straight-wing aircraft, there's no force that will bring the airplane back to wings-level flight without *you* intervening. And while that may be good for an aerobatic aircraft or fighter jet, it's not something you want in your general aviation aircraft or airliner.

How Dihedral Fixes The Problem

When you add dihedral, you add lateral stability when your aircraft rolls left or right. Here's how it works: let's say you're flying along and you accidentally bump your controls, rolling your plane to the right. When your wings have dihedral, two things happen:

1) First, your airplane starts slipping to the right. That means the relative wind is no longer approaching directly head-on to the aircraft, and instead is approaching slightly from the right. This means that there is a component of the relative wind that is acting inboard against the right wing.

As Aircraft Banks Right, It Starts Slipping Right As Well, Changing The Relative Wind





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2) Second, because the relative wind has the inboard component, and because the wings are tilted up slightly, a portion of the relative wind strikes the underside of the low wing, pushing it back up toward wings-level. What's really happening here is the low wing is flying at a higher AOA, and producing slightly more lift.

As Aircraft Slips Right, Relative Wind Strikes Under Side Of Low Wing, Creating Rolling Motion To The Left



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The more dihedral your aircraft has, the more pronounced the effect becomes. But for most aircraft, they only have a few degrees of dihedral, which is *just enough* to return your wings to level during small disturbances, like turbulence, or bumping your flight controls in the cockpit.

It's Not All Good News: Dihedral Comes At A Cost

Dihedral isn't always good, and like almost every design factor, it comes with a cost. In this case, there are two costs: increased [drag](#), and decreased roll rate.



Wings with dihedral don't produce lift completely vertically. There's a vertical component, and a horizontal component. So when you're flying straight and level, your lift is not 100% vertical.

And, the same dihedral effect that keeps your wings level in turbulence, works against you when you try to roll right or left. When you put an aircraft into a bank, the dihedral effect constantly tries to return your wings to level. And with enough dihedral, your roll rate can be dramatically decreased. While that's good for stability, it's bad for maneuvering.

Dihedral Reduces Roll Rate Because Low Wing Produces More Lift



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Dihedral Is Pretty Useful

Dihedral lets you fly more hands-off, even in turbulence. And a more hands-off, stable airplane is good for everybody. Especially when you're trying to manage multiple things in the cockpit, like your checklist, your charts, and maybe even your coffee.

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Don't forget the anhedral on upper wing big planes, where everything works in the opposite way (even induced roll, by rudder inputs)

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Colin Cutler

Colin is a Boldmethod co-founder and lifelong pilot. He's been a flight instructor at the University of North Dakota, an airline pilot on the CRJ-200, and has directed the development of numerous commercial and military training systems. You can reach him at colin@boldmethod.com.

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