How Crosswind Kites Fly

Model airplanes can be flown as high-speed kites. How? Attach two lines to the underside of the wing just in front of the wing spar or center of pressure, then pull on the lines to bank the wings left or right as it flies. These kites are very simple, with no moving parts such as motors, control surfaces, wheels, etc. They aren't big, because when they fly fast, they pull very hard on the lines.

How do they work? Think of a kite line as replacing gravity as one of the forces acting on the airframe. Wherever you attach the line is the equivalent of the center of gravity on a free flying plane. On small hand-flown models, the two lines attach to tabs on the bottom of the wing, which is moving through the air at the highest angle of attack that it can maintain without stalling. Sounds like a glider, doesn't it? That's right, except that the lift that it generates isn't just enough to hold the plane in the air, it's being used to move the plane forward, like a sail moves a sailboat. And the amount of lift created increases as the square of the wind speed. This means that when the wind blows a little faster, the wing creates a lot more lift. This extra lift pulls the plane forward, increasing the speed of the wind hitting the model, or apparent wind. This extra wind speed then creates more lift, and on and on.

Another force acting on the model as it flies is the stabilizer pushing the tail down so that the wing flies at a high, but not stalling, angle of attack. Without this down-force on the tail, wings like those on airplanes are hard to stabilize. Of course, having a tail with an elevator and rudder looks normal on airplanes, but kites such as deltas or parafoils don't usually have an aerodynamic stabilizer to hold them at the optimum angle to the wind. Instead, they rely on bridles that hold their airfoils at a stable angle of attack relative to the line. For streamlined, built-up airframes, however, bridals create a lot of drag, and an airplane-like tail works very well because it adapts itself readily to changes in the angle of the wind as it strikes the wing.

Of course, there is one more very important force acting on the airframe, drag. The greatest source of drag is as a byproduct of lift, so the wing is the chief culprit. The better the lift to drag ratio of the model, the faster it can go. This is why airplane-shaped kites with no bridals, just two very fine Spectra lines, can go much faster in a given wind than conventional deltas or parafoil kites. When you fly them there is no loud sound of flapping surfaces or buzzing bridals, just a very high-pitched zing of the two lines.

An airplane-shaped kite, even a small, relatively inefficient one such as a 2-3 foot span P51 model, has a higher lift-to-drag ratio than that of a parafoil or delta kite, so the airplane-shaped kite will go faster, since since the lift increases as the square of the wind speed. This means that small improvements to the lift-to-drag ratio result in big increases in kite speed.

How can you gauge the lift to drag ratio? For the airframe itself, you can measure the glide angle it achieves if you weight the nose so that it glides as well as possible and then give it a gentle toss as a glider in no wind. Of course, when flying as a kite, the lines add considerable drag, but this test will give you at least a relative indication of the lift-to-drag ratios of different airframes.

This is a quick introduction to some of the forces acting on a kite airframe as it flies across the wind.