Cross With Care

Sideslips and crabbing can be **effective** for landing but have **limitations and consequences**

BERNAL SABORIO

BY **JAMES ALBRIGHT** james@code7700.com

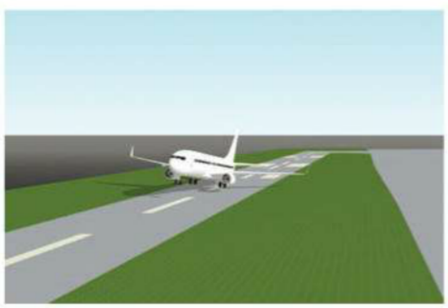
As pilots we learn to deal with crosswind landings almost from Day One of our training. Chances are this was in a primary flight trainer that weighed less than your car and was accomplished with what some call the "wing low" method, something more properly called a sideslip. This could very well be a valid technique for the airplane you are flying now but probably isn't.

Rather, your aircraft's manufacturer may require crosswind landings be made in a crab, with the aircraft turned into the wind and ensuring the wings are level throughout the touchdown. That's the technique demanded for most business jets with the crab removed just prior to or at the moment of touchdown. A few aircraft allow pilots to choose from the different methods as the situation dictates.

Unfortunately, some aircraft flight manuals are devoid of procedures or techniques and simply state that a particular method be used. Few aircraft qualification courses spend any time on crosswind landings, assuming that it is a skill pilots carry from aircraft to aircraft. The procedures used with one aircraft type, however, could be strictly forbidden in the next.

If you fly for a large airline, your manuals may have been written with standardization in mind and your options might be artificially narrowed to make it easier to move from one of the carrier's airplane types to another. In the business aviation world things can get complicated; pilots may need to relearn basic procedures every time they move to a different aircraft model.

If your aircraft's manufacturer allows more than one crosswind technique, you should know the pros and cons of each. But if the manufacturer specifies a particular method, use that, while understanding its limitations. Each method has advantages and disadvantages.



Touchdown in a Sideslip

The sideslip technique aligns the airplane with the extended runway centerline so that touchdown occurs on the runway centerline with the upwind landing gear touching first. The aircraft is initially flown in a crab to correct for drift. Downwind rudder is used to align the longitudinal axis of the aircraft with the runway, and ailerons are used to lower the wing into the wind to eliminate drift.

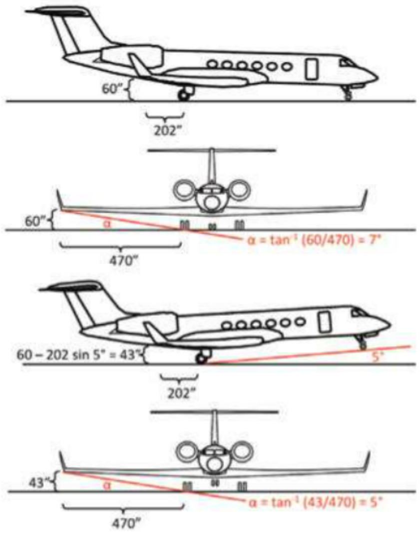
Theoretically, once the sideslip controls are established, rudder and ailerons remain nearly fixed. But gusty winds and changes in wind direction or velocity make control position more fluid. After touchdown, controls may need to be adjusted to keep the airplane tracking down the runway and the wings level.

Primary aircraft trainers tend to use the sideslip technique to minimize side loads on their relatively fragile landing gear struts and to instill in the students the importance of maintaining runway centerline. But, as already noted, this is far from a universal procedure.

Many aircraft with wide, swept wings prohibit or limit the use of the sideslip technique to prevent wingtip or engine pod strikes with the runway. A Boeing 737 NG, for example, permits sideslip landings in crosswinds of up to 23 kt. Various models of Boeings, including the venerable 747, also permit the sideslip method with similar restrictions.

Looking at a Boeing 737 NG, the reason for the restriction is obvious: The bottom of the engine cowl is just 18 in. above the pavement. But what about an aircraft with tail-mounted engines and lots of ground clearance?

Even though fully loaded, a Gulfstream V's wingtips are about 60 in. off the ground. The bank angle on touchdown necessary to strike a wing is lower than you might think. Looking at the airplane when it is stationary in a three-point attitude leads one to believe there is room to spare. But do the math, and you discover it would take only 7 deg. of bank to strike a wingtip. If the nose is flared to 5 deg., which is about right for most landings, the tips are lowered 17 in. The bank angle for a wingtip strike decreases from 7 to only 5 deg.



Prolonging the flare in an effort to grease the landing further raises the nose and lowers the wingtip. Any yaw into the low wing brings the wingtip even closer to the runway. As a result, a sideslip landing is not recommended in a Gulfstream V. Aircraft with lower wings are even more prone to this problem. The Bombardier BD-700 flight manual, for example, limits bank on touchdown to only 3 deg.

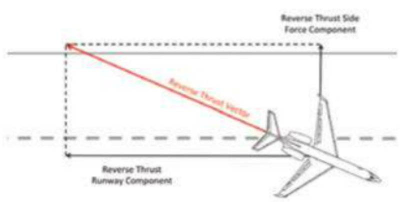
Touchdown in a Crab

A touchdown in a crab keeps the wings level throughout the maneuver, eliminating the fear of a wingtip or engine pod striking the runway. Touching with both landing gear struts simultaneously allows pilots to immediately deploy ground spoilers and thrust reversers on those aircraft that first require weight-on-wheels on the two main gear struts for activation. Pilots may need to consciously apply rudder to align the aircraft with the runway after touchdown, taking care to keep the wings level with ailerons.

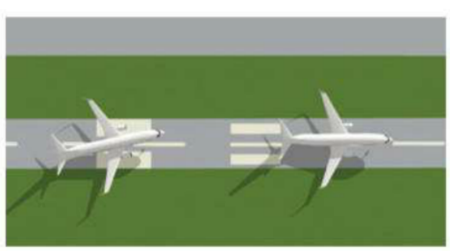
However, many aircraft prohibit landing in a crab, presumably for fear of excessive side loads on landing gear struts. Aircraft that permit the practice often require the crab be removed when the crosswinds exceed given values. While landing in a crab may seem to be the easiest crosswind landing procedure, it has its own set of complications.

When planning on touchdown in a crab, it may be necessary to fly the approach to place the cockpit upwind of runway centerline so as to allow the main gear to touch on centerline. The amount of displacement can be significant on a very long aircraft. A Boeing 747, for example, may require the cockpit be flown 30 ft. or more upwind of runway centerline. Boeing recommends this technique on its longer aircraft. The upwind distance is negligible for most business jets.

On dry runways, the airplane tracks toward the upwind edge of the runway on touchdown in a crab. Immediate upwind aileron is needed to ensure the wings remain level while rudder is needed to track the runway centerline. The greater the crab angle at touchdown, the larger the lateral deviation from the point of touchdown. Boeing does not recommend touchdown in a crab when landing on a dry runway in strong crosswinds.



Landing in a crab on slippery runways can pose problems with reverse thrust directional control. As the aircraft weather vanes into the wind, the reverse thrust will have a tendency to pull the aircraft to the downwind side of the runway. Using nosewheel steering can make the situation worse if cornering friction is lost. Pilots may have no choice but to return the reverse thrust to idle, return to centerline, and reattempt reverse thrust once the aircraft is aligned with the runway.



De-crab

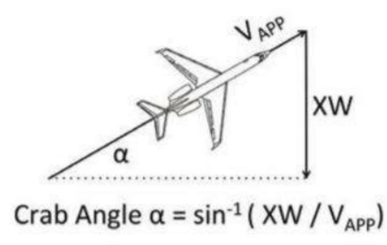
Most aircraft with long, swept wings require the approach be made with wings level and crabbed into the wind, then de-crabbed at some point just prior to, during or at the moment of touchdown. The moment of de-crab varies by aircraft, with one manufacturer specifying doing so 200 ft. above the runway and others recommending the crab be maintained for as long as possible prior to touchdown. The objective is to keep the wings level throughout the approach, flare and touchdown.

The de-crab is begun by applying rudder to align the aircraft with the runway, which will cause the upwind wing to roll in the direction of the rudder input. Ailerons are used to counter this roll and to maintain wings level. The touchdown is optimally made with cross controls and the upwind gear touching down just prior to the downwind gear. It has been said that an optimal de-crab is a transition from the crab to the sideslip, interrupted by a landing.

Regardless of method, pilots must adhere to the manufacturer's maximum demonstrated or limiting crosswind to ensure the airplane can successfully transition from air vehicle to ground machine.

Wind Check

Your aircraft flight manual may not list a crosswind limitation but rather a demonstrated limit. Aircraft certified under 14 CFR 25 need only demonstrate controllability in a crosswind of at least 20 kt., or 20% of its reference stall speed in the landing configuration, whichever is greater. But it need not exceed 25 kt. The resulting demonstrated maximum may or may not be the aircraft's true limiting crosswind. Pilots have no way of knowing the aircraft's true limiting crosswind, but making at least part of the final approach in a crab provides a sneak peek at what the wind is really doing.



Pilots can check a tower's reported winds with the apparent angle of the airplane prior to de-crabbing.

The angle is found by dividing the crosswind component by the approach speed, and then pulling out a scientific calculator and looking for the inverse sine function, usually seen as "arcsin" but sometimes "sin-1" on some calculators. If you are flying a GV, your limiting crosswind will be reached at 28 kt. You can construct a simple table of common approach speeds with the limiting angle by dividing 28 by each speed and taking the inverse sine:

Gulfstream V Crab Angle Required to Stop a 28-kt. Crosswind Drift

VAPP	110	120	130
Limiting Crab Angle	15 deg.	13 deg.	12 deg.

Armed with this knowledge, a GV pilot would be well advised to go around from a landing that leaves the airplane with more than 15 deg. of crab angle prior to a de-crab.

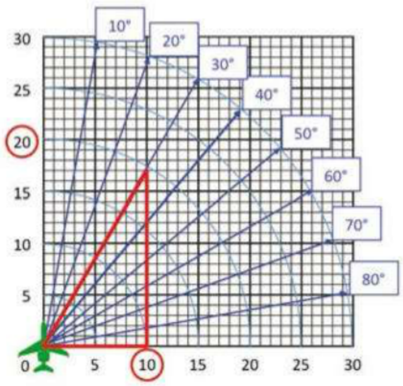
Aircraft allowed to land in a sideslip provide pilots with a true indication that the limiting crosswind has been reached when full aileron or rudder control deflection is needed to maintain runway centerline.

In 2007, an American Eagle Embraer 145LR lined up on final for Dallas Love Field's Runway 31R with the reported wind from 250 deg. at 27 kt. gusting to 38. Aside from the wind, the weather was good and the runway was dry. The 33-kt. crosswind exceeded the airplane's "demonstrated maximum" of 30 kt.

While the pilots can be forgiven for thinking 3 kt. is "close enough," they did ignore an important item of basic stick and rudder skill on their way to landing and subsequently departing the runway surface. Eight seconds prior to touchdown, the pilot needed full left aileron to kill the drift and nearly all the rudder to align with the runway. Predictably, the pilot was unable to keep the airplane on the runway but managed to get the airplane stopped without hurting anyone. While it may seem obvious when second-guessing an aircraft accident report, it bears saying explicitly. If you cannot maintain the extended runway centerline in a sideslip with full ailerons into the wind, you are beyond your aircraft's crosswind limit.

Truly professional pilots heed crosswind limitations, even ones listed merely as a "demonstrated maximum." Unfortunately, reported tower winds are not given in component values and it may be necessary to refer to a chart or table to translate. You may be tempted to guess in the heat of battle, but you can do better.

Three rules of thumb will help you immediately determine the crosswind component from a reported wind velocity:



(1) The crosswind component of a wind 30 deg. from heading is equal to one-half of the full wind factor. For example: a 20-kt. wind 30 deg. off heading has a 10-kt. crosswind component.

(2) The crosswind component of a wind 45 deg. from heading is about three-quarters of the full wind factor. (The exact answer is one divided by the square root of two, or 0.707.) For example, a 20-kt. wind 45 deg. off heading has about a 15-kt. crosswind component.

(3) The crosswind component of a wind 60 deg. from heading is about nine-tenths of the full wind factor. (The exact answer is the square root of three divided by two, or 0.866.) For example, a 20-kt. wind 60 deg. off heading has about an 18-kt. crosswind component.

Once you've decided you are within your aircraft's limiting or maximum demonstrated crosswind, all that is left is to fly the airplane. But you must do that all the way down and until the aircraft comes to a stop.

An Emphasis on Airmanship

In 2003, a FedEx pilot landing in Memphis had the crab on approach just right, initiated the de-crab just right but then relaxed all controls prior to touchdown. The resulting drift may have startled the pilot, who then froze the aircraft's pitch. The aircraft hit hard in about 6 deg. of drift, causing the right landing gear to collapse and destroying the airplane. There were no fatalities, except perhaps a career or two.

Some airlines standardize crosswind landing procedures across a fleet, if possible. In the business jet world that may not be possible. Every time pilots move from one aircraft to another, they must be willing to adapt to new procedures and techniques. The tried and true "wing low" crosswind landing may not work in the new jet. Most swept-wing jets with large wingspans require a form of the de-crab method. Pilots must time the de-crab properly. Too early risks a wingtip or engine pod strike. Too late risks landing in a crab and possible gear collapse. Even if timed correctly, pilots must continue to fly the airplane through the approach, landing flare, touchdown and rollout.

NTSBT

Regardless of the method employed, pilots must understand the limitations of each and obey the limitations of the airplane to avoid getting cross with the wind. B&CA