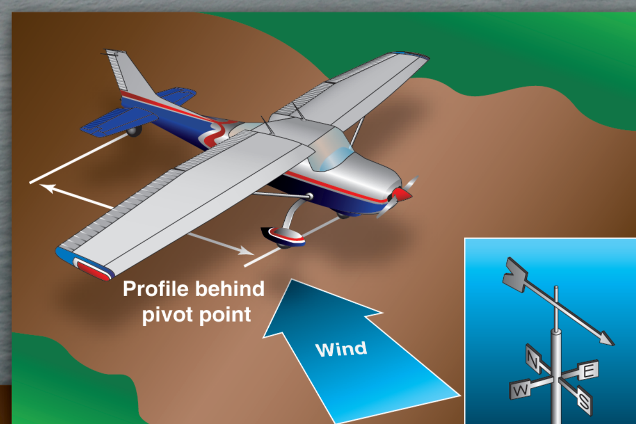
Chapter 13

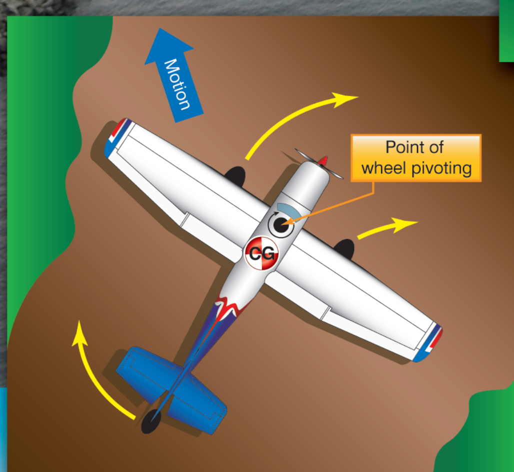
Transition to Tailwheel Airplanes

Introduction

Due to their design and structure, tailwheel airplanes (tailwheels) exhibit operational and handling characteristics different from those of tricycle-gear airplanes (nosewheels). *[Figure 13-1]* In general, tailwheels are less forgiving of pilot error while in contact with the ground than are nosewheels. This chapter focuses on the operational differences that occur during ground operations, takeoffs, and landings.

Although still termed "conventional-gear airplanes," tailwheel designs are most likely to be encountered today by pilots who have first learned in nosewheels. Therefore, tailwheel operations are approached as they appear to a pilot making a transition from nosewheel designs.





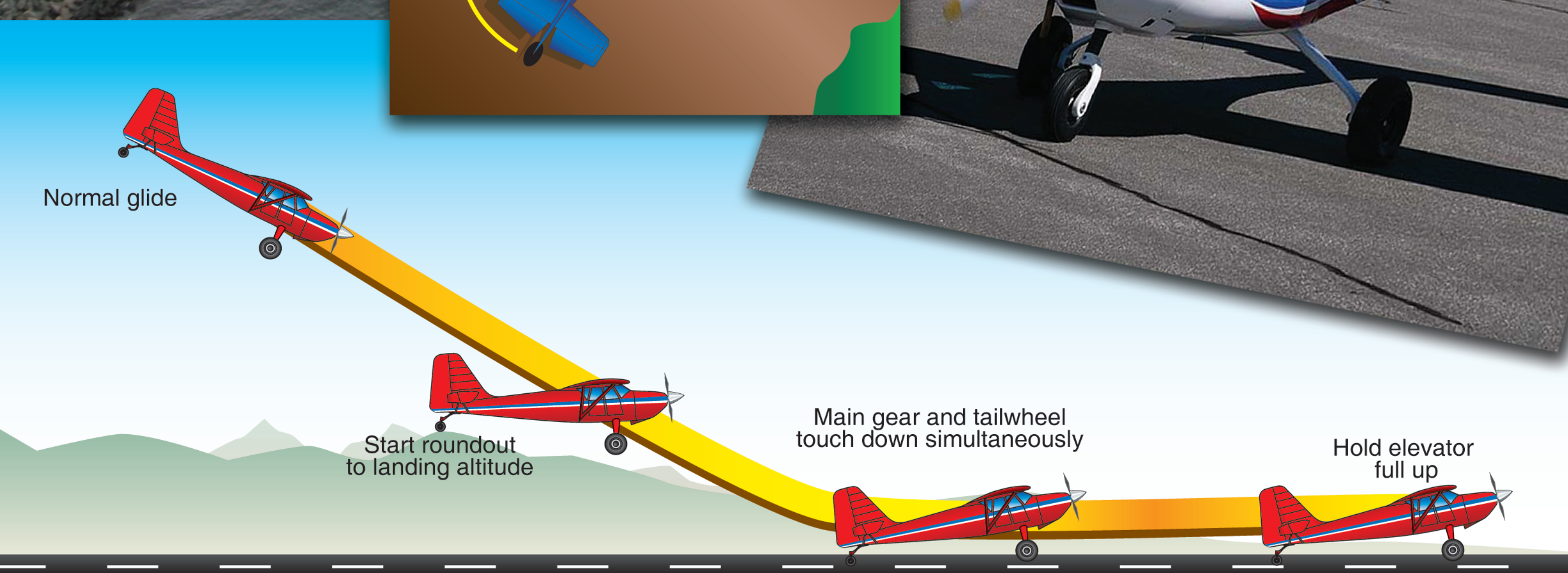


Figure 13-1. *The Piper Super Cub on the left is a popular tailwheel airplane. The airplane on the right is a Mooney M20, which is a nosewheel (tricycle gear) airplane.*

Landing Gear

The main landing gear forms the principal support of the airplane on the ground. The tailwheel also supports the airplane, but steering and directional control are its primary functions. With the tailwheel-type airplane, the two main struts are attached to the airplane slightly ahead of the airplane's center of gravity (CG), so that the plane naturally rests in a nose-high attitude on the triangle created by the main gear and the tailwheel. This arrangement is responsible for the three major handling differences between nosewheel and tailwheel airplanes. They center on directional instability, angle of attack (AOA), and crosswind weathervaning tendencies.

Proper usage of the rudder pedals is crucial for directional control while taxiing. Steering with the pedals may be accomplished through the forces of airflow or propeller slipstream acting on the rudder surface or through a mechanical linkage acting through springs to communicate steering inputs to the tailwheel. Initially, the pilot should taxi with the heels of the feet resting on the floor and the balls of the feet on the bottom of the rudder pedals. The feet should be slid up onto the brake pedals only when it is necessary to depress the brakes. This permits the simultaneous application of rudder and brake whenever needed. Some models of tailwheel airplanes are equipped with heel brakes rather than toe brakes. As in nosewheel airplanes, brakes are used to slow and stop the aircraft and to increase turning authority when tailwheel steering inputs prove insufficient. Whenever used, brakes should be applied smoothly and evenly.

Instability

Because of the relative placement of the main gear and the CG, tailwheel aircraft are inherently unstable on the ground. As taxi turns are started, the aircraft begins to pivot on one or the other of the main wheels. From that point, with the CG aft of that pivot point, the forward momentum of the plane acts to continue and even tighten the turn without further steering inputs. In consequence, removal of rudder pressure does not stop a turn that has been started, and it is necessary to apply an opposite input (opposite rudder) to bring the aircraft back to straight-line travel.

If the initial rudder input is maintained after a turn has been started, the turn continues to tighten, an unexpected result for pilots accustomed to a nosewheel. In consequence, it is common for pilots making the transition between the two types to experience difficulty in early taxi attempts. As long as taxi speeds are kept low, however, no serious problems result, and pilots typically adjust quickly to the technique of using rudder pressure to start a turn, then neutralizing the pedals as the turn continues, and finally using an opposite pedal input to stop the turn and regain straight line travel.

Because of this inbuilt instability, the most important lesson that can be taught in tailwheel airplanes is to taxi and make turns at slow speeds.

Angle of Attack

A second strong contrast to nosewheel airplanes, tailwheel aircraft make lift while on the ground any time there is a relative headwind. The amount of lift obviously depends on the wind speed, but even at slow taxi speeds, the wings and ailerons are doing their best to aid in liftoff. This phenomenon requires care and management, especially during the takeoff and landing rolls, and is again unexpected by nosewheel pilots making the transition.

Taxiing

On most tailwheel-type airplanes, directional control while taxiing is facilitated by the use of a steerable tailwheel, which operates along with the rudder. The tailwheel steering mechanism remains engaged when the tailwheel is operated through an arc of about 30° each side of center. Beyond that limit, the tailwheel breaks free and becomes full swiveling. In full swivel mode, the airplane can be pivoted within its own length, if desired. While taxiing, the steerable tailwheel should be used for making normal turns and the pilot's feet kept off the brake pedals to avoid unnecessary wear on the brakes.

When beginning to taxi, the brakes should be tested immediately for proper operation. This is done by first applying power to start the airplane moving slowly forward, then retarding the throttle and simultaneously applying pressure smoothly to both brakes. If braking action is unsatisfactory, the engine should be shut down immediately.

To turn the airplane on the ground, the pilot should apply rudder in the desired direction of turn and use whatever power or brake necessary to control the taxi speed. At very low taxi speeds, directional response is sluggish as surface friction acting on the tailwheel inhibits inputs trough the steering springs. At normal taxi speeds, rudder inputs alone should be sufficient to start and stop most turns. During taxi, the AOA built in to the structure gives control placement added importance when compared to nosewheel models.

When taxiing in a quartering headwind, the upwind wing can easily be lifted by gusting or strong winds unless ailerons are positioned to "kill" lift on that side (stick held into the wind). At the same time, elevator should be held full back to add downward pressure to the tailwheel assembly and improve tailwheel steering response. This is standard control positioning for both nosewheel and tailwheel airplanes, so the difference lies only in the added tailwheel vulnerability created by the fuselage pitch attitude.

When taxiing with a quartering tailwind, this fuselage angle reduces the tendency of the wind to lift either wing. Nevertheless, the basic vulnerability to surface winds common to all tailwheel airplanes makes it essential to be aware of wind direction at all times, so holding the stick away from the cross wind is good practice (left aileron in a right quartering tailwind).

Elevator positioning in tailwinds is a bit more complex. Standard teaching tends to recommend full forward stick in any degree of tailwind, arguing that a tailwind striking the elevator when it is deflected full down increases downward pressure on the tailwheel assembly and increases directional control. Equally important, if the elevator were to remain deflected up, a strong tailwind can get under the control surface and lift the tail with unfortunate consequences for the propeller and engine.

While stick-forward positioning is essential in strong tailwinds, it is not likely to be an appropriate response when winds are light. The propeller wash in even lightly-powered airplanes is usually strong enough to overcome the effects of light tailwinds, producing a net headwind over the tail. This in turn suggests that back stick, not forward, does the most to help with directional control. If in doubt, it is best to sample the wind as you taxi and position the elevator where it will do the most good.

Weathervaning

Tailwheel airplanes have an exaggerated tendency to weathervane, or turn into the wind, when operated on the ground in crosswinds. This tendency is greatest when taxing with a direct crosswind, a factor that makes maintaining directional control more difficult, sometimes requiring use of the brakes when tailwheel steering alone proves inadequate to counteract the weathervane effect.

Visibility

In the normal nose-high attitude, the engine cowling may be high enough to restrict the pilot's vision of the area directly ahead of the airplane while on the ground. Consequently, objects directly ahead are difficult, if not impossible, to see. In aircraft that are completely blind ahead, all taxi movements should be started with a small turn to ensure no other plane or ground vehicle has positioned itself directly under the nose while the pilot's attention was distracted with getting ready to takeoff. In taxiing such an airplane, the pilot should alternately turn the nose from one side to the other (zigzag) or make a series of short S-turns. This should be done slowly, smoothly, positively, and cautiously.

Directional Control

After absorbing all the information presented to this point, the transitioning pilot may conclude that the best approach to maintaining directional control is to limit rudder inputs from fear of overcontrolling. Although intuitive, this is an incorrect assumption: the disadvantages built in to the tailwheel design sometimes require vigorous rudder inputs to maintain or retain directional control. The best approach is to understand the fact that tailwheel aircraft are not damaged from the use of too much rudder, but rather from rudder inputs held for too long.

Normal Takeoff Roll

Wing flaps should be lowered prior to takeoff if recommended by the manufacturer. After taxiing onto the runway, the airplane should be aligned with the intended takeoff direction, and the tailwheel positioned straight or centered. In airplanes equipped with a locking device, the tailwheel should be locked in the centered position. After releasing the brakes, the throttle should be smoothly and continuously advanced to takeoff power. At all times on the takeoff roll, care must be taken to avoid applying brake pressure.

After a brief period of acceleration, positive forward elevator should be applied to smoothly lift the tail. The goal is to achieve a pitch attitude that improves forward visibility and produces a smooth transition to climbing flight as the aircraft continues to accelerate. If the attitude chosen is excessively steep, weight transfers rapidly to the wings, making crosswind control more difficult. If the attitude is too flat, crosswind control is also diminished, a counter-intuitive result that is discussed in the Crosswind section of this chapter.

It is important to note that nose-down pitch movement produces left yaw, the result of gyroscopic precession created by the propeller. The amount of force created by this precession is directly related to the rate the propeller axis is tilted when the tail is raised, so it is best to avoid an abrupt pitch change. Whether smooth or abrupt, the need to react to this yaw with rudder inputs emphasizes the increased directional demands common to tailwheel airplanes, a demand likely to be unanticipated by pilots transitioning from nosewheel models.

As speed is gained on the runway, the added authority of the elevator naturally continues to pitch the nose forward. During this stage, the pilot should concentrate on maintaining a constant-pitch attitude by gradually reducing elevator deflection. At the same time, directional control must be maintained with smooth, prompt, positive rudder corrections. All this activity emphasizes the point that tailwheel planes start to "fly" long before leaving the runway surface.

Liftoff

When the appropriate pitch attitude is maintained throughout the takeoff roll, liftoff occurs when the AOA and airspeed combine to produce the necessary lift without any additional "rotation" input. The ideal takeoff attitude requires only minimum pitch adjustments shortly after the airplane lifts off to attain the desired climb speed.

All modern tailwheel aircraft can be lifted off in the three-point attitude. That is, the AOA with all three wheels on the ground does not exceed the critical AOA, and the wings will not be stalled. While instructive, this technique results in an unusually high pitch attitude and an AOA excessively close to stall, both inadvisable circumstances when flying only inches from the ground.

As the airplane leaves the ground, the pilot must continue to maintain straight flight and hold the proper pitch attitude. During takeoffs in strong, gusty winds, it is advisable to add an extra margin of speed before the airplane is allowed to leave the ground. A takeoff at the normal takeoff speed may result in a lack of positive control, or a stall, when the airplane encounters a sudden lull in strong, gusty wind or other turbulent air currents. In this case, the pilot should hold the airplane on the ground longer to attain more speed, then make a smooth, positive rotation to leave the ground.

Crosswind Takeoff

It is important to establish and maintain proper crosswind corrections prior to lift-off; that is, application of aileron deflection into the wind to keep the upwind wing from rising and rudder deflection as needed to prevent weathervaning.

Takeoffs made into strong crosswinds are the reason for maintaining a positive AOA (tail-low attitude) while accelerating on the runway. Because the wings are making lift during the takeoff roll, a strong upwind aileron deflection can bank the airplane into the wind and provide positive crosswind correction before the aircraft lifts from the runway. The remainder of the takeoff roll is then made on the upwind main wheel. As the aircraft leaves the runway, the wings can be leveled as appropriate drift correction (crab) is established.

Short-Field Takeoff

With the exception of flap settings and initial climb speed as recommended by the manufacturer, there is little difference between the techniques described above for normal takeoffs. After liftoff, the pitch attitude should be adjusted as required for obstacle clearance.

Soft-Field Takeoff

Wing flaps may be lowered prior to starting the takeoff (if recommended by the manufacturer) to provide additional lift and transfer the airplane's weight from the wheels to the wings as early as possible. The airplane should be taxied onto the takeoff surface without stopping on a soft surface. Stopping on a soft surface, such as mud or snow, might bog the airplane down. The airplane should be kept in continuous motion with sufficient power while lining up for the takeoff roll.

As the airplane is aligned with the proposed takeoff path, takeoff power is applied smoothly and as rapidly as the powerplant will accept without faltering. The tail should be kept very low to maintain the inherent positive AOA and to avoid any tendency of the airplane to nose over as a result of soft spots, tall grass, or deep snow.

When the airplane is held at a nose-high attitude throughout the takeoff run, the wings progressively relieve the wheels of more and more of the airplane's weight, thereby minimizing the drag caused by surface irregularities or adhesion. Once airborne, the airplane should be allowed to accelerate to climb speed in ground effect.

Landing

The difference between nosewheel and tailwheel airplanes becomes apparent when discussing the touchdown and the period of deceleration to taxi speed. In the nosewheel design, touchdown is followed quite naturally by a reduction in pitch attitude to bring the nosewheel tire into contact with the runway. This pitch change reduces AOA, removes almost all wing lift, and rapidly transfers aircraft weight to the tires.

In tailwheel designs, this reduction of AOA and weight transfer are not practical and, as noted in the section on Takeoffs, it is rare to encounter tailwheel planes designed so that the wings are beyond critical AOA in the three-point attitude. In consequence, the airplane continues to "fly" in the three-point attitude after touchdown, requiring careful attention to heading, roll, and pitch for an extended period.

Touchdown

Tailwheel airplanes are less forgiving of crosswind landing errors than nosewheel models. It is important that touchdown occurs with the airplane's longitudinal axis parallel to the direction the airplane is moving along the runway. *[Figure 13-2]* Failure to accomplish this imposes Side loads on the landing gear which leads to directional instability. To avoid side stresses and directional problems, the pilot should not allow the airplane to touch down while in a crab or while drifting.

There are two significantly different techniques used to manage tailwheel aircraft touchdowns: three-point and wheel landings. In the first, the airplane is held off the surface of the runway until the attitude needed to remain aloft matches the geometry of the landing gear. When touchdown occurs at this point, the main gear and the tailwheel make contact at the same time. In the second technique (wheel landings), the airplane is allowed to touch down earlier in the process in a lower pitch attitude, so that the main gear touch while the tail remains off the runway.

Three-Point Landing

As with all landings, success begins with an orderly arrival: airspeed, alignment, and configuration well in hand crossing the threshold. Round out (level-off) should be made with the main wheels about one foot off the surface. From that point forward, the technique is essentially the same that is used in nosewheels: a gentle increase in AOA to maintain flight while slowing. In a tailwheel aircraft, however, the goal is to attain a much steeper fuselage angle than that commonly used in nosewheel models; one that touches the tailwheels at the same time as the mainwheels.

With the tailwheel on the surface, a further increase in pitch attitude is impossible, so the plane remains on the runway, albeit tenuously. With deceleration, weight shifts increasingly from wings to wheels, with the final result that the plane once again becomes a ground vehicle after shedding most of its speed.

There are two potential errors in attempting a three-point landing. In the first, the mainwheels are allowed to make runway contact a little early with the tail still in the air. With the CG aft of the mainwheels, the tail naturally drops when the mainwheels touch, AOA increases, and the plane becomes airborne again. This "skip" is easily managed by re-flaring and again trying to hold the plane off until reaching the three-point attitude.

In the second error, the plane is held off the ground a bit too long so that the in-flight pitch attitude is steeper than the three-point attitude. When touchdown is made in this attitude,

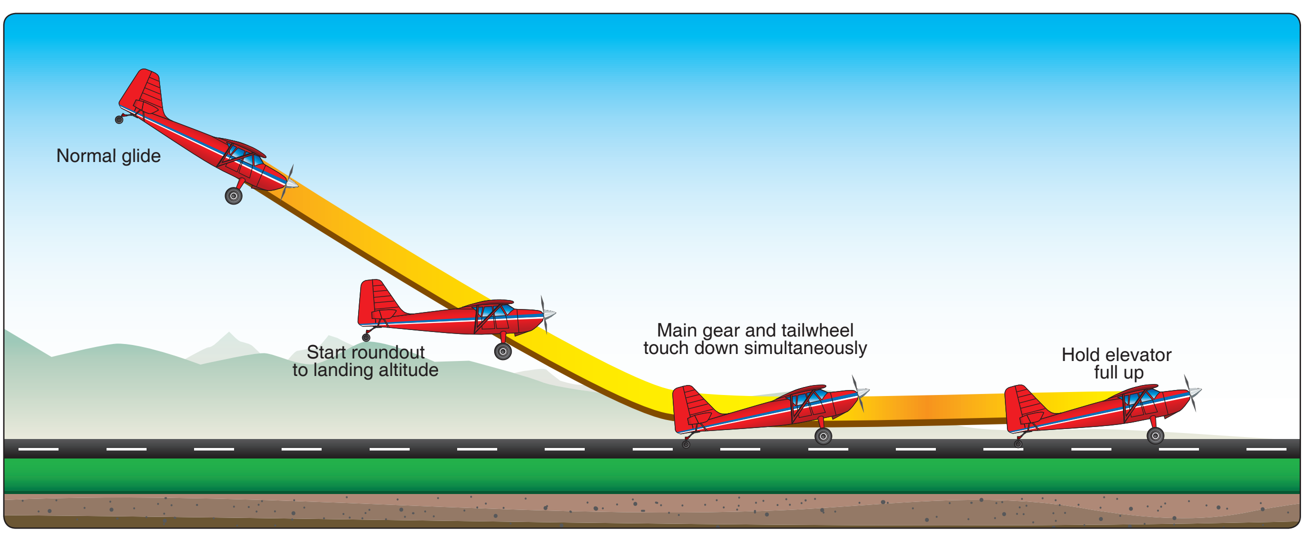


Figure 13-2. *Tailwheel touchdown.*

the tail makes contact first. Provided this happens from no more than a foot off the surface, the result is undramatic: the tail touches, the plane pitches forward slightly onto the mainwheels, and rollout proceeds normally.

In every case, once the tailwheel makes contact, the elevator control should be eased fully back to press the tailwheel on the runway. Without this elevator input, the AOA of the horizontal stabilizer develops enough lift to lighten pressure on the tailwheel and render it useless as a directional control with possibly unwelcome consequences. This after-landing elevator input is quite foreign to nosewheel pilots and must be stressed during transition training.

NOTE: Before the tailwheel is on the ground, application of full back elevator during the flare lowers the tail, increases the AOA, and quite naturally puts the plane in climbing flight.

Wheel Landing

In some wind conditions, the need to retain control authority may make it desirable to make contact with the runway at a higher airspeed than that associated with the three-point attitude. This necessitates landing in a flatter pitch attitude on the mainwheels only, with the tailwheel still off the surface. *[Figure 13-3]* As noted, if the tail is off the ground, it tends to drop and put the plane airborne, so a soft touchdown and a slight relaxation of back elevator just after the wheels touch are key ingredients to a successful wheel landing.

If the touchdown is made at too high a rate of descent, the tail is forced down by its own weight, resulting in a sudden increase in lift. If the pilot now pushes forward in an attempt to again make contact with the surface, a potentially dangerous pilot-induced oscillation may develop. It is far better to respond to a bounced wheel landing attempt by initiating a go-around or converting to a three-point landing if conditions permit.

Once the mainwheels are on the surface, the tail should be permitted to drop on its own accord until it too makes ground contact. At this point, the elevator should be brought to the full aft position and deceleration should be allowed to proceed as in a three-point landing.

NOTE: The only difference between three-point and wheel landings is the timing of the touchdown (early and later). There is no difference between the approach angles and airspeeds in the two techniques.

Crosswinds

As noted, it is highly desirable to eliminate crab and drift at touchdown. By far the best approach to crosswind management is a side-slip or wing-low touchdown. Landing in this attitude, only one mainwheel makes initial contact, either in concert with the tailwheel in three-point landings or by itself in wheel landings.

After-Landing Roll

The landing process must never be considered complete until the airplane decelerates to the normal taxi speed during the landing roll or has been brought to a complete stop when clear of the landing area. The pilot must be alert for directional control difficulties immediately upon and after touchdown, and the elevator control should be held back as far as possible and as firmly as possible until the airplane stops. This provides more positive control with tailwheel steering, tends to shorten the after-landing roll, and prevents bouncing and skipping.

Any difference between the direction the airplane is traveling and the direction it is headed (drift or crab) produces a moment about the pivot point of the wheels, and the airplane tends to swerve. Loss of directional control may lead to an aggravated, uncontrolled, tight turn on the ground, or a ground loop. The

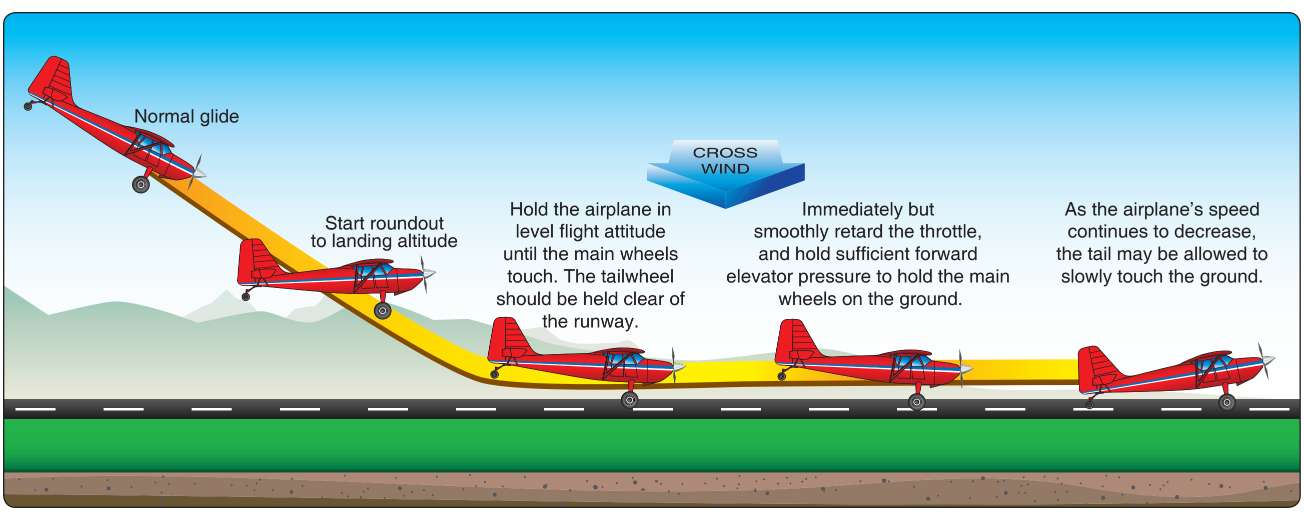


Figure 13-3. *Wheel landing.*

combination of inertia acting on the CG and ground friction of the main wheels during the ground loop may cause the airplane to tip enough for the outside wingtip to contact the ground and may even impose a sideward force that could collapse one landing gear leg. *[Figure 13-4]* In general, this combination of events is eliminated by landing straight and avoiding turns at higher than normal running speed.

To use the brakes, the pilot should slide the toes or feet up from the rudder pedals to the brake pedals (or apply heel pressure in airplanes equipped with heel brakes). If rudder pressure is being held at the time braking action is needed, that pressure should not be released as the feet or toes are being slid up to the brake pedals because control may be lost before brakes can be applied. During the ground roll, the airplane's direction of movement may be changed by carefully applying pressure on one brake or uneven pressures on each brake in the desired direction. Caution must be exercised when applying brakes to avoid overcontrolling.

If a wing starts to rise, aileron control should be applied toward that wing to lower it. The amount required depends on speed because as the forward speed of the airplane decreases, the ailerons become less effective.

If available runway permits, the speed of the airplane should be allowed to dissipate in a normal manner by the friction and drag of the wheels on the ground. Brakes may be used if needed to help slow the airplane. After the airplane has been slowed sufficiently and has been turned onto a taxiway or clear of the landing area, it should be brought to a complete stop. Only after this is done should the pilot retract the flaps and perform other checklist items.

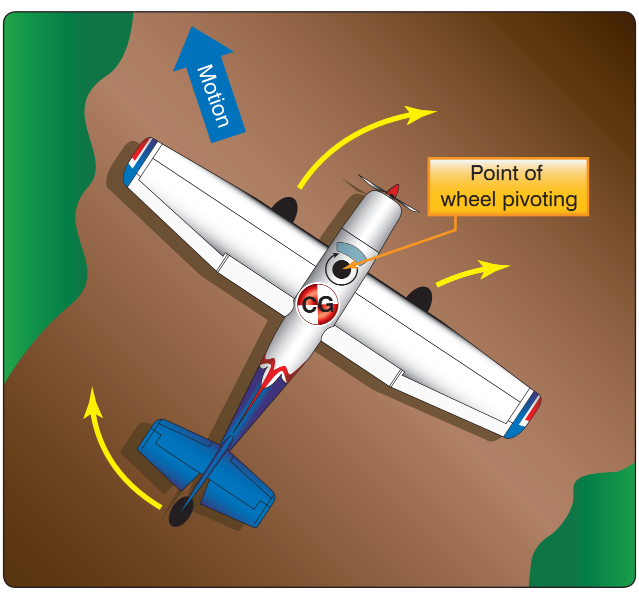


Figure 13-4. *Effect of CG on directional control.*

Crosswind After-Landing Roll

Particularly during the after-landing roll, special attention must be given to maintaining directional control by the use of rudder and tailwheel steering while keeping the upwind wing from rising by the use of aileron. Characteristically, an airplane has a greater profile or side area behind the main landing gear than forward of it. With the main wheels acting as a pivot point and the greater surface area exposed to the crosswind behind that pivot point, the airplane tends to turn or weathervane into the wind. *[Figure 13-5]* This weathervaning tendency is more prevalent in the tailwheel-type because the airplane's surface area behind the main landing gear is greater than in nosewheel-type airplanes.

Pilots should be familiar with the crosswind component of each airplane they fly and avoid operations in wind conditions that exceed the capability of the airplane, as well as their own limitations. While the airplane is decelerating during the after-landing roll, more aileron must be applied to keep the upwind wing from rising. Since the airplane is slowing down, there is less airflow around the ailerons and they become less effective. At the same time, the relative wind is becoming more of a crosswind and exerting a greater lifting force on the upwind wing. Consequently, when the airplane is coming to a stop, the aileron control must be held fully toward the wind.

Short-Field Landing

Upon touchdown, the airplane should be firmly held in a three-point attitude. This provides aerodynamic braking by the wings. Immediately upon touchdown and closing the throttle, the brakes should be applied evenly and firmly to minimize the after-landing roll. The airplane should be stopped within the shortest possible distance consistent with safety.

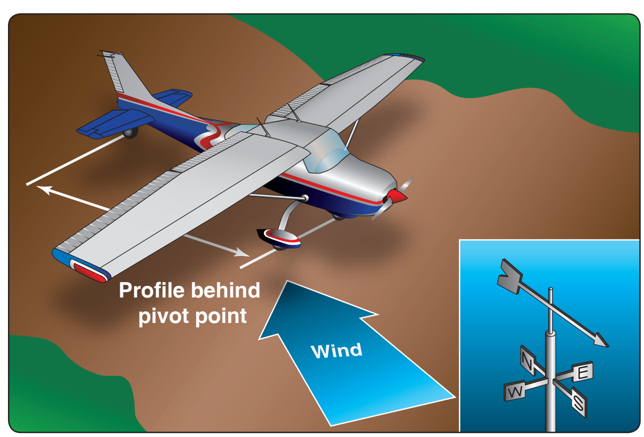


Figure 13-5. *Weathervaning tendency.*

Soft-Field Landing

The tailwheel should touchdown simultaneously with or just before the main wheels and should then be held down by maintaining firm back-elevator pressure throughout the landing roll. This minimizes any tendency for the airplane to nose over and provides aerodynamic braking. The use of brakes on a soft field is not needed because the soft or rough surface itself provides sufficient reduction in the airplane's forward speed. Often, it is found that upon landing on a very soft field, the pilot needs to increase power to keep the airplane moving and from becoming stuck in the soft surface.

Ground Loop

A ground loop is an uncontrolled turn during ground operations that may occur during taxi, takeoff, or during the after-landing roll. Ground loops start with a swerve that is allowed to continue for too long. The swerve may be the result of side-load on landing, a taxi turn started with too much groundspeed, overcorrection, or even an uneven ground surface or a soft spot that retards one main wheel of the airplane.

Due to the inbuilt instability of the tailwheel design, the forces that lead to a ground loop accumulate as the angle between the fuselage and inertia, acting from the CG, increase. If allowed to develop, these forces may become great enough to tip the airplane to the outside of the turn until one wing strikes the ground.

To counteract the possibility of an uncontrolled turn, the pilot should counter any swerve with firm rudder input. In stronger swerves, differential braking is essential as tailwheel steering proves inadequate. It is important to note, however, that as corrections begin to become apparent, rudder and braking inputs need to be removed promptly to avoid starting yet another departure in the opposite direction.

Chapter Summary

This chapter focuses on the operational differences between tailwheel and nosewheel airplanes that occur during ground operations, takeoffs, and landings. The chapter covers specific topics, such as landing gear, taxiing, visibility, liftoff, and landing. Comparisons are given as to how each react during the takeoff and landing, as well as situations that should be avoided. Pilots who use proper rudder control techniques should be able to transition to tailwheel airplanes without too much difficulty.