When Runways Are Wet and Slippery...

Tips on keeping the airplane on the straight and narrow—whether it wants to or not

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■■ The shock of seeing a Boeing 747 being blown *backwards* off a taxiway into a 50-foot-deep ravine sounds like the overworked imagination of a Hollywood screenwriter. But to Japan Air Lines' Capt. Noboru Kaneda and his crew, this scene is not fictitious; it is embarrassingly real.

About a year ago, Capt. Kaneda taxied JAL Flight 422 onto an ice-coated, east-west taxiway at Anchorage International Airport during a scheduled departure for Tokyo. While taxiing slowly in a 20-knot crosswind (with gusts to 33 knots), he experienced considerable braking and steering difficulty. Finally, he stopped the aircraft, ordered that the engines be shut down and called for a tractor to tow the 747 off the icy surface.

But then the aircraft yielded to the crosswind and began to behave like a giant weathervane. After turning 70° into the wind and with the powerful parking brakes still engaged, the 747 was *blown backwards* off the taxiway and slid tail-first down a shallow embankment. The aircraft came to rest ungracefully at the bottom of a ravine about 250 feet later. (Although it appeared that the 747 was damaged beyond repair, Boeing felt otherwise. The aircraft has since been returned to service with JAL.)

This is a graphic example of how a pilot can unwittingly become a passenger in his own airplane. It is obvious that if such a tragedy can occur to a 608,000-pound 747, similar accidents can (and do) involve large numbers of smaller aircraft.

Although much has been written about the methods to be used during approaches and landings, very little attention is devoted to what is often the wildest, most uncontrollable aspect of flight—the landing roll. When runways are wet and slippery, the usually simple task of stopping an airplane can become nightmarishly difficult or even impossible. With winter upon us, this seems an appropriate time to review the techniques that can prevent a pilot from sliding helplessly down a runway toward an appointment with an airframe repair shop.

When approaching a short or wet runway, it is imperative that the aircraft cross the boundary at as slow an airspeed as is consistent with safety. Once over the runway, however, avoid prolonged flaring in an attempt to impress passengers with a "greaser." It is far more important to get the airplane on the ground as soon as possible—firmly if necessary. After touchdown, do not hold the nose high in an effort to take advantage of aerodynamic drag. Very few lightplanes have sufficient drag profiles (at touchdown speeds) to be of significant value in decreasing airspeed. Additionally, a nose-high attitude decreases the efficiency of wheel brakes.

When a wing is "flown"—at any airspeed—it develops some lift. The larger the angle of attack, the greater the lift. A wing, therefore, does produce measurable lift during the landing rollout. It is not sufficient to raise the airplane, of course, but it does prevent the landing gear from supporting the entire weight of the aircraft. This decreases braking effectiveness because brakes perform in proportion to the amount of weight on the wheels. To increase braking power, therefore, it is necessary to destroy lift and weigh down the main gear as much as possible. Holding up the nose after touch-

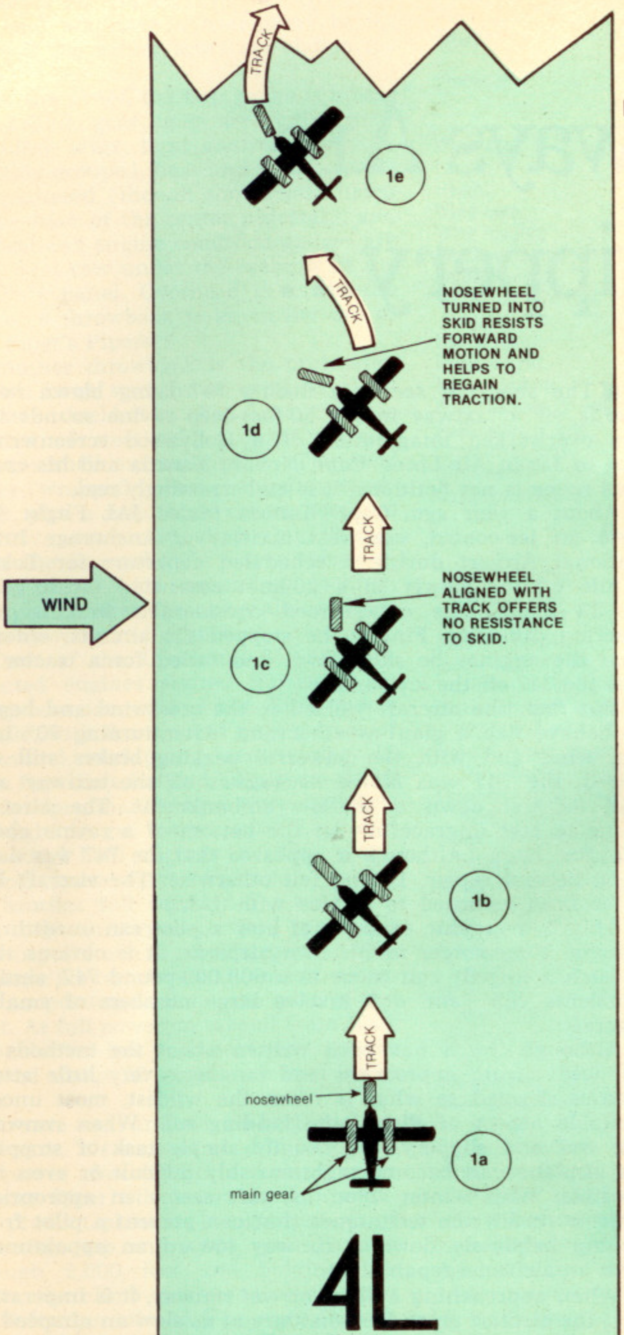

Figure 1

down reduces the load on the main wheels and increases landing distance. (Maintaining a nose-high attitude for purposes of aerodynamic braking is an effective technique, however, for reducing wear and tear on brake linings and tires when runway length is not critical.)

Contrary to popular opinion, the primary purpose of the spoilers on the wings of a jetliner is not to create drag during the landing roll. Instead, these devices are used to destroy lift. When spoilers are deployed, the added weight on the wheels immediately increases braking efficiency.

In addition to lowering the nose after touchdown, there's something else the general aviation pilot can do to kill lift: raise the flaps—immediately. This further reduces the effective angle of attack and, in some cases, decreases wing area. The result is reduced lift and improved braking.

The FAA, however, is opposed to retracting flaps during the landing roll. The administration feels that a befuddled pilot might grab the wrong switch and inadvertently retract the landing gear instead. Although this indeed shortens the landing roll, it can be an extremely expensive technique.

When retracting the flaps after touchdown, it is mandatory that a pilot *think* about the switch he is about to move.

On some airplanes, such as early model Cherokees, heavy braking with flaps extended causes an unpleasant maneuver called wheelbarrowing. Because of a rearward center of lift with flaps down, heavy braking causes the main wheels to lift partially from the runway and places considerable weight on the nosewheel. When this occurs, braking is poor and directional control can be dangerously marginal. This is another argument for retracting flaps when heavy braking is required despite FAA's admonition on this procedure.

Since it is desirable to place as much weight as possible on the main wheels (the braking wheels), then very little aircraft weight should be supported by the nosewheel. But heavy braking creates a nose-down pitching moment that tends to plant the nosewheel firmly on the ground. This should be countered by corresponding back pressure on the control wheel to keep aircraft weight off the nosewheel and on the mains.

A raised elevator has the added benefit of increasing the aerodynamic down-load (negative lift) on the tail. This creates additional "weight" to burden the main gear and increases braking effectiveness.

As forward speed reduces, back pressure should be increased gradually until the control wheel is fully aft. If directional control becomes difficult, then weight should be added to the nosewheel by releasing sufficient back pressure to increase nosewheel steering effectiveness.

Applying the brakes requires more than simply stomping on the binders and is similar to the technique recommended to make a panic stop in an automobile (especially when the surface is slick). The brakes should be applied firmly until reaching a point beyond which skidding would occur. Additional braking and the resultant skid can reduce braking potential as much as 50% to say nothing of possible tire failure and loss of directional control. The best braking occurs at the point of an incipient skid.

Since an airline pilot cannot hear the anguish of screeching tires above the assaulting roar of reverse thrust, his aircraft is usually equipped with an anti-skid system, an electronic device that senses when a wheel is about to stop rotating. An electronic signal is sent to the brake of that wheel and causes that brake to release, preventing a locked wheel and possible blowout. As the wheel begins to accelerate, brake pressure is re-applied. All of this is automatic and requires nothing of the pilot except a firm, steady application of the brakes.

Since most light aircraft are not so equipped, the pilot is required to be a human anti-skid device.

Should the pilot sense a skid or hear screeching tires, this is his warning to release the brakes gradually until the skidding symptoms disappear. He then re-applies brake pressure and tries to approach a skid without actually encountering one. This "modulation of braking torque" results in the shortest possible landing roll.

Skidding is especially hazardous on slick surfaces when landing with a crosswind. Figure 1 helps to describe the problem and the cure.

In Figure 1a, the aircraft touches down and the pilot applies excessive brake pressure resulting in skidding and loss of tire traction. Because of momentum (1b), the aircraft continues to track the runway centerline but, lacking traction, it also weathervanes into the crosswind.

Most pilots (and automobile drivers) react to a left skid by turning the nosewheel to the right (1c). The problem is compounded because this aligns the nosewheel with the direction of travel and does little to change aircraft heading.

The proper procedure (1d) calls for a bit of courage and faith because it requires acting contrary to natural instinct. Initially, release the brakes and either neutralize the nosewheel or turn it in the direction of the skid (left, in this case). This offers the best chance of regaining control. As tire traction takes effect, the aircraft (1d) will begin to track toward the edge of the runway. Then, gradually steer the aircraft toward the right and re-apply brake pressure (but not too much). A return to the centerline (1e) can be assisted by using slight differential braking and, if flying a twin, asymmetrical power.

It is especially important in winter when wet runways are often the rule to make sure that aircraft tires are in good condition. Deep treads contribute significantly to maintaining traction and directional control. Bald tires and slippery surfaces are a particularly hazardous combination.

Stopping is complicated, of course, when the runway is either wet or ice-coated, but few appreciate how adversely these factors degrade braking performance. On the average, a wet runway decreases braking effectiveness by 50% and an icy surface can more than double the minimum landing distance.

When landing on a short, slippery surface, try to touch down on that area of the runway least coated with rubber marks because these deposits can make an even damp surface extraordinarily slick.

Landing downwind on other than a clean, dry runway is an invitation to disaster unless the available distance is measured in miles rather than feet.

Assume, for example, that an airplane with a 60-mph touchdown airspeed is landing with a 10-mph tailwind. At touchdown, this aircraft has a groundspeed of 70 mph, 20 mph faster than when landing into the wind. More significantly, it will hurtle down the runway with almost twice as much kinetic energy. Simply stated, the brakes will be required to work twice as hard to stop the airplane. (Kinetic energy varies with the square of the groundspeed and is exactly 96% greater at 70 mph than at 50 mph.)

There are times, however, when an airplane won't respond to any braking technique and, despite the will of its master, continues to water ski almost uncontrollably along the runway. This is called hydroplaning and is a situation that develops when water immediately in front of and under a tire can't get out of the way fast enough to allow the tire to come into direct contact with the runway surface. Instead, the tire (and the rest of the airplane) rises above and becomes supported by a thin, dynamic film of water.

When hydroplaning occurs, the brakes are absolutely useless. The wheels stop (or possibly rotate backwards), but since they are not in direct contact with the runway surface, almost no frictional force is available to decelerate the aircraft. So now you're an FAA-certificated water skier.

There is a simple formula used to determine the speed at and above which hydroplaning can be expected to occur: hydroplaning speed (knots) equals nine times the square root of the tire pressure. The recommended tire pressure of a Cessna Skylane, for example, is 42 psi. This airplane can be expected to hydroplane (under the right conditions) at a groundspeed at or above $9 \times \sqrt{42} = 9 \times 6.5 = 58$ knots (67 mph). Hydroplaning in a Skylane, for example, can be avoided, therefore, by landing with a *groundspeed* of less than 67 mph. This is another reason to avoid wet, downwind landings.

Flying with under-inflated tires causes hydroplaning at slower speeds. If a Skylane has tires pressurized to only 35 psi, for example, hydroplaning can be expected at or above $9 \times \sqrt{35} = 53$ knots = 61 mph. Maintaining recommended (or slightly higher) tire pressures not only increases tire longevity but can avoid nasty surprises on wet tarmac.

When landing at a soaked airport, hydroplaning can be avoided also by landing on a grooved runway (if available). Lateral runway grooves not only allow water to drain away, but these channels provide escape paths for water being "pressured" by an approaching tire, thus keeping the tire footprint relatively dry. A grooved runway is also rough and prevents the surface from becoming slick.

When landing on a wet runway that poses the threat of hydroplaning, there is a useful technique that allows a pilot to test the water prior to becoming committed to a full-stop landing. Immediately after touchdown, simultaneously lower the nose, retract flaps to the takeoff position (if practical) and apply moderate braking pressure. If there is no noticeable deceleration and hydroplaning cannot be tolerated with respect to the available runway length, immediately add full power, abort the landing and consider landing elsewhere.

If the runway is sufficiently long, however, raise the nose and use aerodynamic drag to decelerate to below the hydroplaning speed where braking will eventually become effective. As the brakes take hold, lower the nose and use the stopping technique described earlier.

Although landing on a near-frictionless runway can be critical, don't ignore related takeoff problems.

Takeoff distance is increased substantially by a runway coated with snow, slush or standing water. With respect to snow, consider that the resistance to acceleration offered by a given thickness of snow increases as temperature decreases. In other words, the colder the snow, the more drag it creates.

If a relatively short runway is covered with a thick fresh coat of snow that might prevent proper acceleration, consider one of these recommendations: borrow a car and make a takeoff path in the snow; accomplish the same thing in your airplane by taxiing two or three times along the entire centerline; or, wait for someone else to take off and follow in his or her "footprints."

Curiously, a takeoff on smooth ice results in better than normal acceleration because of considerably reduced rolling friction. But be cautious of crosswinds and bear in mind that a safe abort might be impossible. This is an especially important point for multi-engine pilots. Ice can increase the accelerate-stop distance dramatically. On a sufficiently slippery surface, the "go/no-go" speed (V_1) might be as slow as 40 knots.

There are times when water skiing, snow skiing, ice skating and hot-dogging can be a ball. But flying an airplane is not one of those times. □