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Get A Better Break From Your Brakes

■■ With long, paved runways available almost everywhere, many pilots are forgetting some of the finer points involved in getting maximum performance from their wheel brakes. There *are* situations that arise, often unexpected, where the brakes mean the difference between a successful flight and disaster.

How long has it been since you practiced a short-field landing to a full stop . . . then checked your rollout distance against the figures you computed from the aircraft handbook? How about the emergency situation where you land a trifle fast and long then have to really climb on the "binders" to get stopped?

The brakes on your aircraft were designed to perform one simple function . . . to stop the wheels from turning. It is the frictional force generated between the tires and the runway surface that causes the aircraft to slow to a stop. The *amount* of braking friction you generate and the length of runway you use in getting stopped is a function of pilot braking technique. Here's what happens:

When you begin applying the brakes a frictional force is generated between the tire and the runway. This is commonly referred to as the braking coefficient of friction. The maximum coefficient of friction, or the point of maximum brake effectiveness, is found just short of where wheel skidding occurs.

An unbraked wheel generally has a rolling friction coefficient of around 0.02 to 0.05. As you apply brakes the friction rises until it reaches a peak at about the 18% to 20% rolling skid point. In other words, the wheels are rolling at 80% of their normal speed.

However, up to this point, almost no skidding or slipping has actually occurred. The apparent skid, or slip, in this region of maximum friction, is due to the tensional elasticity of the tire. Once you pass the peak friction point the tire very rapidly locks up in a total skid. At this time your braking friction rapidly diminishes.

When you land on a long runway, and use light braking action, the brakes absorb all of the stopping energy. This is the case with most of our day-to-day landing operations. Under these conditions very little tire-tread wear occurs. But when you lock the wheels in a full skid the brakes don't absorb *any* of the stopping energy. Instead, the tires take the full load. This results in much less stopping force and disastrous tire-tread wear.

Skidding tires are absolutely uncontrollable. Once the tire wears through it blows out. Then you're really in trouble.

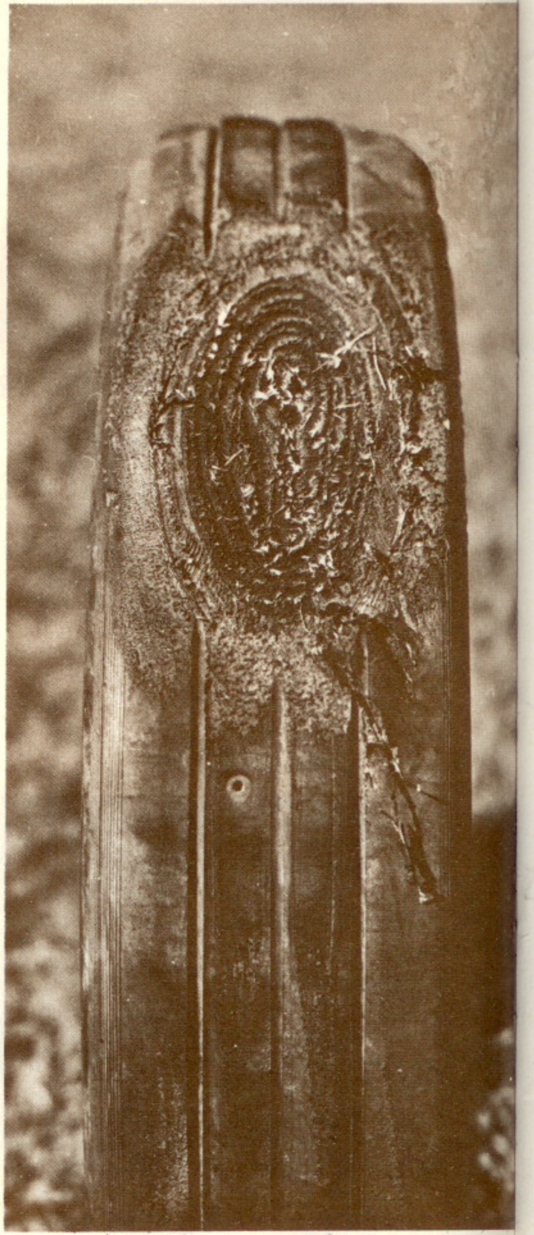
Two things happen in a skid. First, the rubber starts to scuff and tear off into little pieces. These in turn act like rollers underneath the tire. Second, the friction heat generated by the skid starts to melt the rubber. This molten rubber then becomes a lubricant underneath the tire, causing your friction value to become almost nil. If, for example, you happen to lock or skid one wheel, the aircraft will actually turn *away* from the skidding wheel. Further brake applications will be ineffective.

A pilot must provide two major prerequisites to get maximum performance from the wheel brakes: (a) land at the proper speed (slower than normal for minimum-run landings) and; (b) get maximum weight on the wheels immediately after touchdown.

The importance of correct landing airspeed cannot be emphasized too strongly. To get maximum weight on the wheels a pilot must indulge in various gymnastics which depend on his type of aircraft.

For instance, with a tricycle landing gear, forward stick after touchdown forces the aircraft weight onto the wheels. This is true whether you're flying a Cessna 150 or an F-105. With a conventional three-point landing gear you must land in a full stall and hold the stick full back. If the runway is fairly short or wet, I like to land slightly tail wheel first.

In most all airplanes prompt flap retraction on touchdown is a necessity. This causes an immediate loss of lift which increases the tire footprint pressure (weight on the wheels) and footprint area (amount of tire surface



Skidding tires won't provide the traction for aircraft control. To stop a skid you must completely release the brake pressure then reapply. A blowout can lead to disaster. This one did.

touching the runway). This gives you an increase in coefficient of friction.

Leaving the flaps down after touchdown, causes the aircraft to be light on the landing gear. The tires are thus very susceptible to skids.

As mentioned before, a prolonged skid at high speed means a blowout. Once a wheel starts to skid the only way you can get it rolling and back to the point of peak effectiveness is to *completely release* the brake pressure, then reapply.

Under normal conditions you apply some braking pressure then pause for a moment and reapply. This is good technique. But, for short-landing rolls you'll find a single, smooth, constantly increasing brake pressure the best technique. U.S. Air Force and Navy tests have shown that intermittent heavy braking interrupted by one or two seconds of cooling is not the best procedure. The wheels and brakes usually don't reach dangerous friction heat levels until five to 15 minutes after the braking effort. The brief cooling periods during rollout, do not provide enough cooling to justify the runway you waste. In other words they are not "cost effective" as the saying goes.

Some pilots attempt to cool their brakes by taxiing around the airfield. The hazard here is that any additional brake application will add to your brake heat problem. Often the brakes will fail altogether, leaving you set up for a taxi accident.

The stopping performance figures in the back of each aircraft handbook are compiled from test aircraft using new tires under ideal conditions. Tire wear is an item frequently overlooked by most pilots. Worn tires can significantly influence your stopping performance. They greatly increase your susceptibility to skids.

A new tire on a dry runway may provide a coefficient of friction of 0.8. NASA says that a bald tire, one that is 80% worn or has less than 1/16 inch of tread remaining, will provide only one-half that value, or .4. Obviously then, a slick tire can significantly lengthen your planned stopping distance.

Worn tires contribute to a wet weather phenomenon known as hydroplaning. Here a compressed film of water separates the tires from the runway surface. When this occurs your brakes and nose wheel steering become useless . . . much like wet ice.

Anytime the depth of the water standing on the runway exceeds the tire tread depth you can expect this wet surface skidding. The less tread you have the less water required. Also, traction loss will occur at a slower speed. Smooth or worn tires on smooth pavement need only a heavy dew to rob you of all traction. This phenomenon is especially dangerous in crosswinds as it can cause you to drift off the side of the runway.

When the runway is wet or covered with ice or snow, you'll need to use aerodynamic braking. (Loose gravel and wet grass require it, too.) This is a pilot technique commonly used when the wheel brakes are relatively ineffective.

With most aircraft having tricycle landing gear this means a nose-high rollout, and stick full back even after you've lowered the nose. The "up" elevator provides some aerodynamic drag. You'll also want to leave the flaps full down, along with anything else you've got to hang out in the wind.

There are several "tricks of the trade" when it comes to aerodynamic braking. For instance, if you fly a Cessna 150, which has forward opening doors on each side, they can be opened simultaneously to provide a speed-brake effect. Of course, you'll need a partner in the right seat. This technique is most often used during a landing on ice and snow where the brakes are never really effective at any speed. You can even make heading changes by opening and closing the doors asymmetrically.

Another aid is to shut down the engine to get rid of the residual (idle) thrust . . . unless of course you need the engine for hydraulic pressure. This makes aerodynamic braking effective to a lower speed.

(The handbook for some of the heavier light-twins calls for nose down immediately on touchdown. Be sure to consult your handbook for the recommended technique.)

No discussion of brakes and braking would be complete without a word about hot brakes. In short, they can be extremely dangerous, especially if you use high-pressure tires.

As mentioned before, maximum heat buildup in a wheel, doesn't occur until five to 15 minutes after heavy braking. The friction heat from the brake is transferred to the wheel and tire. This in turn causes the wheel structure to weaken and the tire pressure to increase dangerously. In extreme cases, the wheel and tire will explode.

Exploding wheels can and have caused the loss of the complete airplane. The shrapnel-like wheel particles puncture the fuel tanks and cause raw fuel and hot brakes to come in contact. This obviously causes a fire.

Often the buckshot-like wheel particles cause major damage to aircraft parked alongside. In some cases mechanics, firemen and onlookers have been killed by flying debris.

So, naturally if you've got your brakes real hot, you'll want to park out by yourself until they cool down. Make certain, though, you don't set the parking brake while the wheels are hot or they'll lock up.

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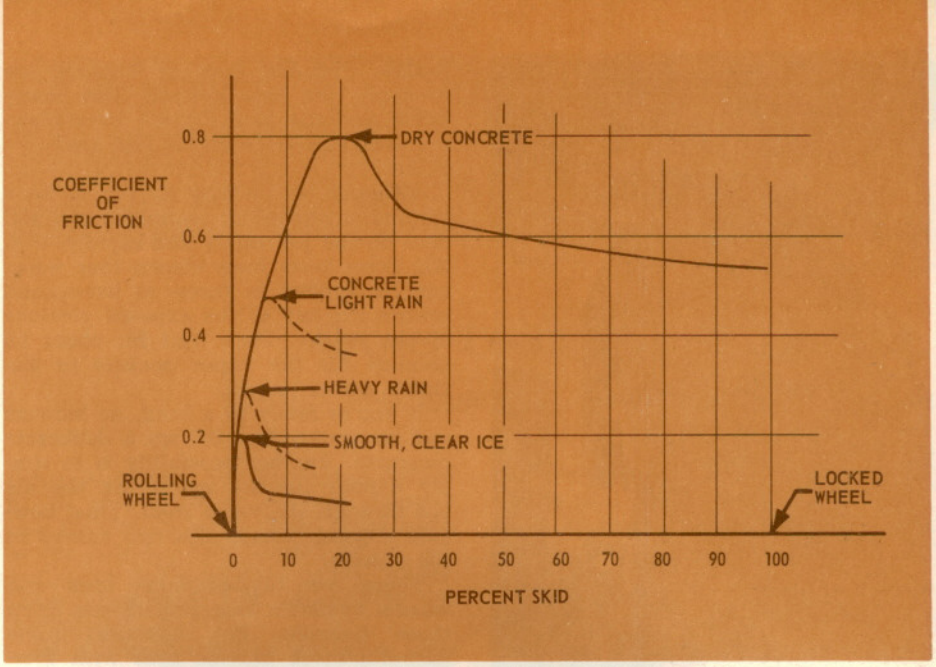

The maximum coefficient of friction obtainable is a function of tire pressure. The lower the tire pressure the greater the friction obtainable. However, all tires perform best at the 18% to 20% rolling skid point.

Proper braking technique may determine whether you stop your plane safely or court disaster in a sticky situation. Here is a guide to the right things to do during landing operations

A tire with more than 80% tread wear, whether on your nose wheel or main gear, needs only a good dew to cause a total traction loss on a smooth paved runway.

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The Air Force says that the proper way to approach a hot brake is from the front or rear, in line with the tread, which is the strongest part of the tire. Then if the wheel should explode the rubber and wheel particles will be blown out to either side.

There are several ways to cool hot brakes. Portable fans or blowers are probably the best method. But many pilots and mechanics don't have blowers available. So what do you use? . . . Water?

Although water may appear to be a traumatic method of cooling, it can and does do the job safely and rapidly. U.S. Air Force tests have shown that water can be applied in three- to five-second squirts directly to the *exposed portions of the brakes*. Then wait for about 15 seconds for the vapor pockets to dissipate and try again.

If you're really in a bind, no blowers and no water close by, try a deliberate puncture. Another possibility is to simply deflate the tire by letting the air out through the valve stem. This, however exposes you to a severe hazard in the process.

There are high-pressure tires and wheels available that protect you from these hazards. For instance, some manufacturers provide tires with thermal plugs built in. If a tire gets too hot and the pressure too great, the plug pops out and the tire deflates. (The excessive heat ruins the tire anyhow.)

Another approach is the fusible wheel plug. It works on the same principle. If the heat buildup gets too great, the wheel rim plug melts and the tire deflates.

Now to summarize, here's what you should remember. It's *your* braking technique that brings the airplane to a safe, sure stop. Remember the basics; be sure you have good tires, land at the proper speed, and keep the wheels *just shy* of a skid. Then you can rest assured that you'll stop in the distance advertised in the handbook.

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THE AUTHOR

Maj. John M. Lowery (USAF) has made a study of the technique required for the proper stopping of airplanes, high-performance jet fighters as well as general aviation aircraft. If you will notice the references at the end of "Get A Better Break From Your Brakes," you will see he also has some pointers to offer on stopping a F-105. Maj. Lowery holds a civil ATR license and flight instructor rating. He soloed in 1945. This is his first appearance in The PILOT as an author. We, along with you, hope it will not be his last. He is stationed at Langley AFB, Virginia.

Mail Routes May Spur Taxi Growth

Chances of further marked growth of the air-taxi industry were brightened by the recent announcement by U.S. Postmaster General Lawrence F. O'Brien that the vast bulk of first class domestic mail soon may be transported by air.

At a press conference in Washington, D.C., O'Brien disclosed that airport mail-handling facilities from coast to coast are being upgraded as part of the extensive airlifting program. It was also indicated that greater reliance in timely movement of mail is being placed on air-taxi operators.

Revealing that all first class mail that can be expedited by air transportation is now being airlifted, O'Brien said that he will propose to Congress in 1969 that the airmail postage rate be eliminated and that airmail and first class mail be merged into a single class, designated priority mail service.

Presently, about 56% of all domestic mail is sent first class, and about 40% of that is being airlifted, O'Brien said. That has been necessitated by the decreasing number of passenger trains that have been available to move the mails, he added, but it also represents a long-term Department program to provide the most expeditious service possible.

An indication of the growing importance of air-taxi operations in mail delivery is apparent in the growing number of Post Office Department contracts with operators other than air carriers. As disclosed last month (see February PILOT, page 46), only 10 air-taxi operators held contracts to carry mail in 1966. At the end of 1967, that number had expanded to 29 air-taxi operators who served some 80 routes encompassing 240 locations. In addition, 515 locations are served primarily by air carrier operations.

During 1967, air-taxi operators earned about $3,600,000 from carrying mail, as compared with payments of about $150,000,000 to the airlines. In fiscal 1968, however, the department expects to increase the number of air-taxi contracts to a total of about $8,000,000, officials disclosed.

Unlike arrangements with the airlines, no standard formula of payment has yet been established for air-taxi operators who seek mail contracts. According to agency officials, each contract is negotiated individually to provide service that is in the best interest of the Post Office Department.

FAA records disclose that scheduled air-taxi operations represent one of civil aviation's most phenomenal areas of growth. On Jan. 1, 1964, there were only 12 such FAA-approved operations in the country. By Nov. 15, 1965, this had expanded to 78 organizations operating 361 aircraft. On Oct. 1, 1967, there were 165 scheduled air-taxi companies in the United States, operating 685 aircraft. □