AIRCRAFT BRAKING

By Capt. M.P. Pappy Papadakis JD

Air Transport aircraft must demonstrate stopping capability in order to be certified to U.S. Standards. This test is accomplished without thrust reversers. The test documents the distance it takes to stop the aircraft at its highest approved V1 speed. This test data result is then utilized to compute accelerate stop distance in the worst (heaviest) case condition. Once these distances are demonstrated they and other tests are used to correlate and compute takeoff allowable weights for each specific runway length.

The manufacturer's brake energy testing data may be discovered, at least for the tests conducted for F.A.A. certification. (They must retain these tests indefinitely)

The trouble with all brake test criteria is that the test criteria tests absolute performance of equipment and not real world conditions. It can be argued that real world data can be interpolated downward from the optimum data. The best argument against real world or worst case testing is that it is cost prohibitive and not really definable.

The brake tests use optimum conditions of dry runway, new tires , new brakes, and a test pilot who is attuned to stopping (most airline pilots are expecting to take off) The test pilot has probably conducted similar testing innumerable times before.

In the real world the tires are old, the brakes worn, and the runway less than optimum and the pilot is not looking forward to maximum stopping. Most airline pilots have never conducted a max braking stop in there entire life. Additionally the runway may be damp, slightly wet, covered with slush, standing water or ice.

Several phenomena that can occur during takeoff- stopping accidents are:

1. Skidding.
2. Brake lockup - anti skid failure.
3. Three varieties of hydroplaning.

The investigator should be capable of recognizing the problems and the investigative clues left behind.

ON TAKE OFF

1. Brakes don't release.
2. Anti skid failure locking one or more wheels (full or partial lock)

ON STOPPING

1. Skidding.
2. Anti skid locks up. (Full or partial lock)
3. Hydroplaning. (3 varieties)

HYDROPLANING

The hydroplaning event occurs because of standing water on a runway at brake application and lock up. Hydroplaning is of three recognized varieties. The results are the same: the wheels lose friction and lock up and slide.

The first is viscous hydroplaning. It is a situation where there is a very thin layer of new rain on the pavement (usually aggregate or asphalt) and there is an oily residue from many cars or other aircraft landings. This combination forms an oily emulsion and sets up a very slippery condition. It only occurs at the beginning of a light rain since a heavy rain would tend to clean the pavement of the oil.

The second is regular Hydroplaning, and it comes about when water stands on the runway surface. As the tire rotates and simultaneously moves forward on this water and pavement some water is forced in front of the tire. This water creates a wedge under the tire and the tire is literally lifted from the pavement on a cushion of water. The result is a total loss of friction. It always seems to occur in a predictable speed range that has a direct correlation with tire pressure of the vehicle.

Hydroplaning occurs at 7 to 9 times the square root of tire pressure.

The third variety of hydroplaning may occur on a pavement where there is less standing water. The braking causes extreme tire heat due to friction. The hot tire reacts with the thin film of

water and creates instant steam. The steam is trapped beneath the tire and portions of the tire are lifted from the pavement on a cushion of hot vapor. Friction is reduced or lost, reverted rubber hydroplaning tends to give the pavement a steam cleaned look as opposed to blackened skid marks.

On takeoff an accident can occur because of one or more locked or dragging tires. On These varieties of accidents the investigator will usually have several distinct clues.

1. Witnesses will say the roll was excessive.
2. Witnesses will say acceleration was slow.
3. Witnesses may say that a tire was smoking.
4. There will be long skid marks on the runway from start of takeoff roll.
5. When a single tire locks it may blow out or skid itself flat through many layers of tread.

On landing or aborted takeoff one or more wheels may lock up in an anti skid system. These will leave black skid marks, and may flatten through several layers of tread.

When a maximum effort stop has occurred and maximum energies have been absorbed by the brake lining it is not unusual to overheat the brake. When this occurs you may have a smoking brake and the tire fuse may melt and blow out causing a flat tire.

In one accident a landing gear main mount had been knocked off. It was not involved in the fire, yet its fuse plugs had blown. From this and the skid marks it was evident that the pilot had tried extremely hard to not run off the end.

In commercial jet cockpits there are three switches (handles) associated with brakes. They are:

1. Park brake set - release.
2. Anti skid switch on -off.
3. Emergency air Brakes.

The investigator should check these.

Again the investigator must understand the system and how it is supposed to operate.