Landing Assured, Departure Not

Just **how firm is terra firma?** Elusive numbers tell all

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It is a given among pilots universally that they must not let their aircraft alight or roll upon any surface not strong enough to support it. That goes for the runway, the ramp and everywhere in between. (Just because you were able to taxi it there, it doesn't mean you'll be able to taxi it back out.)

Knowing in advance whether a surface is up to the task should be a simple matter of checking an airport directory, but alas, life on the flight line is often complicated by inadequate information. And that's often the case regarding load-bearing values of the pavement below. While the International Civil Aviation Organization (ICAO) has devised an Aircraft Classification Number (ACN)/Pavement Classification Number (PCN) system, many airports around the world have yet to embrace it.

Still, if you are armed with your aircraft manuals, a good airport directory, a phone and a little bit of pavement classification knowledge, you should be able to ensure you never find your aircraft sunk into the ramp after the fuel truck nearly doubles the weight on each landing gear leg. This knowledge, as with many things in aviation, begins outside the world dominated by airfoils and turbine engines.

First, some background. U.S. and international regulations dealing with pavement strength all seem to draw from early highway pavement studies by the California Department of Transportation. These studies produced what had been for years the standard in evaluation of the mechanical strength of roads and became known as the California Bearing Ratio (CBR). The U.S. Army Corps of Engineers and the FAA expanded these methods to develop an explicit CBR relating to pavement thickness and an equivalent single-wheel load (ESWL) concept for use by aircraft.

Many countries adopted these and variations of these methods; the result was a confusing mess for pilots trying to determine the suitability of airports when traveling beyond their own borders. The information provided by some aviation manuals can be misleading or just wrong. Several manuals, for example, explain that you can compute an ESWL for your aircraft by simply dividing the ramp weight of the aircraft by the number of main gear wheels. This ignores the fact that the spacing between main gear legs and the wheels on an individual leg are too narrow on many business aircraft to take full credit for each wheel and can understate pavement stress by 40% or more.

The preferred method in the U.S. is to specify weight limits by specific landing gear types expected at each airport. Hanscom Field (BED) in Bedford, Massachusetts, for example, specifies: "single wheel 78.0, double wheel 100.0, double tandem 190.0," where each number is simply the maximum allowable gross weight in thousands of pounds for each aircraft type. The method is simple and works but requires caution. A double wheel, for example, must have wheel centerlines spaced apart by at least 20 in. for lighter aircraft and 34 in. for heavier aircraft to take credit.

The British adopted an earlier ICAO solution in 1965 based on defining a Load Classification Number (LCN) and Load Classification Group (LCG) for each airport. The method is no longer considered precise, especially for asphalt pavements. There are still a few airports in the U.K., South Africa, Turkey and elsewhere that report LCN/LCG ratings. The *Jeppesen Airway Manual* provides a graph to determine an aircraft's LCN/LCG.

The Jeppesen publication often reports load-carrying limits using Runway Weight Limits Per Wheel.

- ▶ **S or SW** — Allowable aircraft weight for single wheel per leg configuration.
- ▶ **T or DW** — Allowable aircraft weight for tandem or dual wheel per leg configuration.
- ▶ **TT or DDW** — Allowable aircraft weight for twin tandem or double dual wheel per leg configuration.
- ▶ **TDT** — Runway weight bearing capacity for aircraft with twin delta tandem landing gear.
- ▶ **DDT** — Runway weight bearing capacity for aircraft with double dual tandem type landing gear.
- ▶ **AUW** — All up weight (without regard to wheel configuration).
- ▶ **S/L** — Load per leg for single wheel per leg configuration.
- ▶ **T/L** — Load per leg for twin or tandem wheel per leg configuration.
- ▶ **TT/L** — Load per leg for bogie or twin tandem wheel per leg configuration.

Runway 07/25 in Battambang, Cambodia, for example, is shown with a limit of "AUW-110." This translates to an "all up weight" without regard to wheel configuration of 110,000 lb.

ICAO established a study group in 1977 to devise a single method of reporting pavement strengths and later adopted the ACN-PCN method. The system works well where it has been implemented but can be confusing because you cannot determine an aircraft's ACN without first understanding the pavement's PCN.

Understanding ACN and PCN

An ACN is a mathematical representation of how much stress the aircraft places on pavement and depends on the type of pavement and its subgrade. Pavement can be either rigid (concrete) or flexible (asphalt). The subgrade can be deemed to be of high, medium, low or ultra-low strength. Aircraft manufacturers typically provide a single chart for each pavement type with

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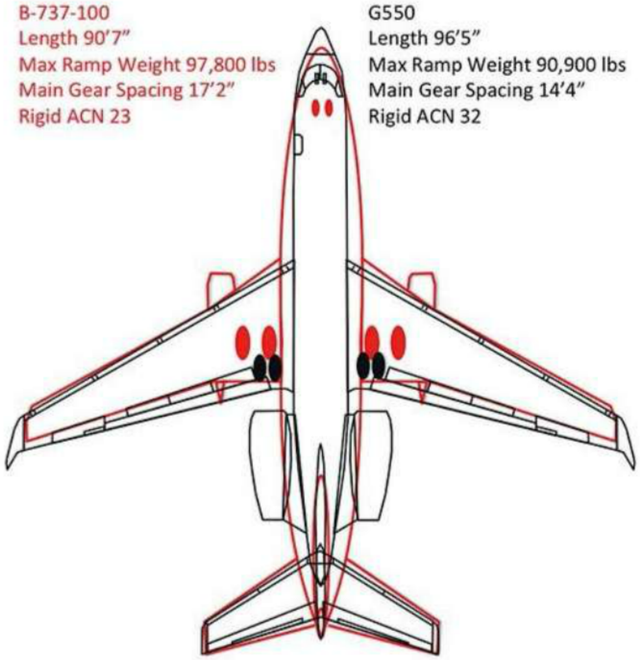
separate lines for each subgrade category.

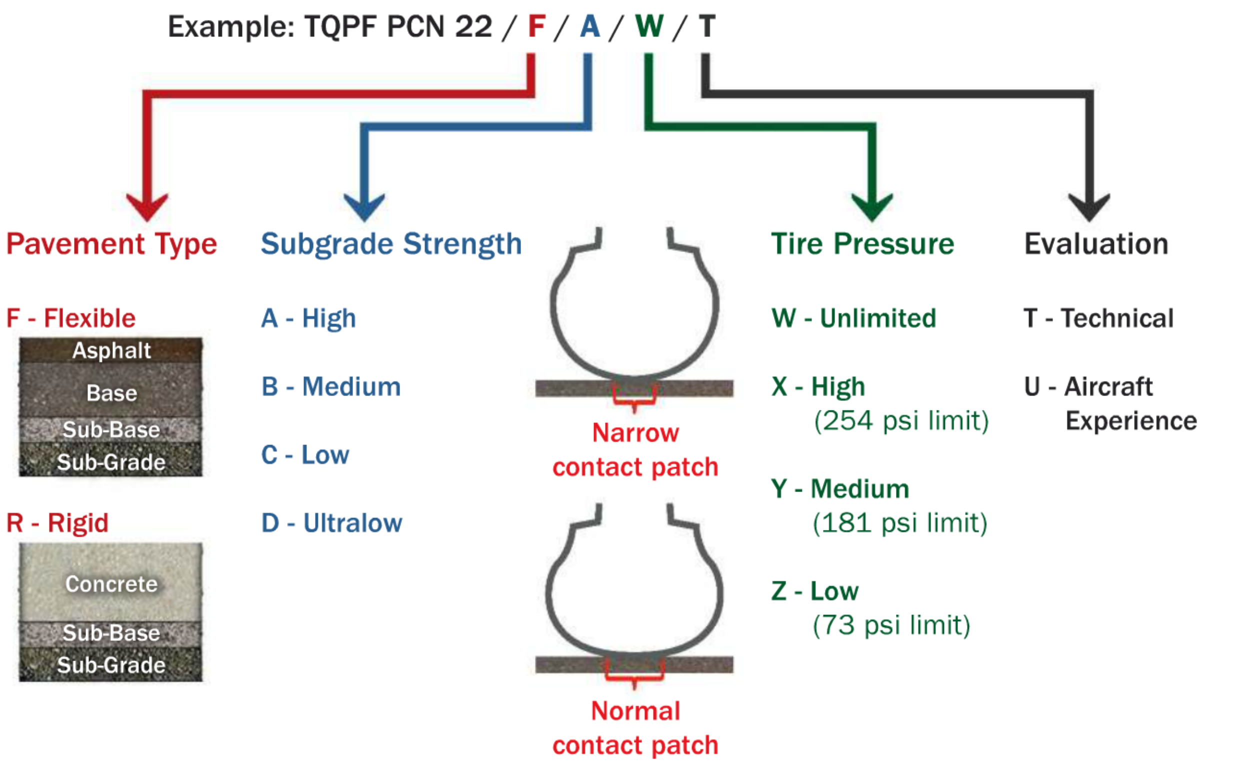
In addition to the type of pavement and subgrade, the two largest determinants of an ACN are the aircraft's weight and wheel spacing. Wheels that are spaced far enough apart spread the impact on the pavement and can reduce an aircraft's ACN considerably. Most business aircraft with dual wheels, however, do not have enough spacing between their wheels to lower the ACN. Thus, even though a fully loaded Gulfstream G550 weighs less than a fully loaded Boeing 737-100, the lighter aircraft has a higher ACN. The stress on the pavement underneath that Gulfstream exceeds that of the Boeing because the main landing gear wheels on the 737 are farther apart.



Aircraft tire pressure also can impact the ACN, though to a much lesser degree than gross weight or wheel spacing. Some manufacturers allow the tires to be deflated slightly, which increases the contact patch of the tire and spreads the weight, though at some cost to tire life.

Meanwhile, the PCN is a theoretical representation of a surface's load carrying capacity for unrestricted operations. The pavement might be able to take more weight, but doing so would shorten its life expectancy. The PCN is presented as a number followed by four letters that further explain how the number was derived.

The first two elements following the PCN are the pavement type and the subgrade strength. Flexible pavements are typically made of asphalt and cover a base, subbase and subgrade. Because the top layer of asphalt has a fair amount of give to it, the subgrade greatly impacts the surface's load carrying ability. Rigid pavements are typically made of Portland cement concrete. The distinction between flexible and rigid is important in determining the PCN, but from a pilot's perspective, the key is to take care when selecting the correct chart.



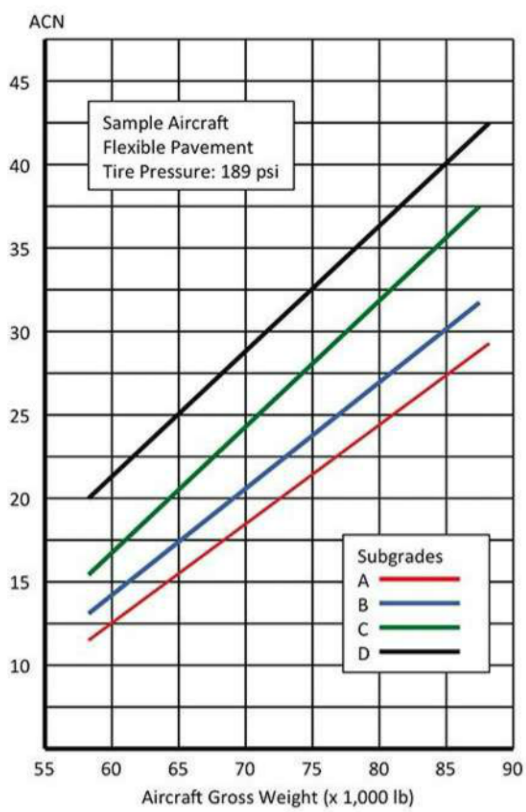
Similarly, the subgrade category is rated high (A), medium (B), low (C) or (U) ultra-low.

The third element in determining the PCN is tire pressure and that is a source of some confusion. Rigid pavements are not greatly affected by tire pressure, but flexible pavements can suffer from higher pressures because the loads are sensed in a smaller area. The PCN remains valid for any tire pressures at or below the maximum pressure of the code. For example, a Gulfstream G450 with standard tire pressures of 189 psi can use runways with PCNs determined at (W) unlimited or (X) high pressures, but will probably not be able to use a pavement tested to (Y) medium or (Z) low pressures.

The fourth element in determining a PCN is simply the method used in its calculation, that is either through a (T) technical evaluation or (U) aircraft experience. The former is an engineering study and is considered very reliable while the latter means those doing the calculation simply track the usage of the pavement and infer the levels based on its tolerance to loads over time. From a pilot's perspective, the technical evaluation is simply a measure of confidence, high or low.

Practical Application

Any aircraft over 12,500 lb. should have data available to help pilots judge its impact on various pavements. Aircraft with large weight ranges, be it fuel, cargo or both, should have charts for various conditions. Typically two charts are used, one for rigid and the other for flexible pavements. On each chart you should find lines representing various subgrade categories.



If you cannot find pavement stress information, you should call the airport management office directly.

The pilot will need to identify the correct chart from the pavement type and the correct line from the subgrade category. It is then a matter entering a proposed gross weight to find the appropriate ACN. If the ACN is less than the reported PCN, the operation is deemed acceptable.

Clayton J. Lloyd International Airport (AXA) in Anguilla, for example, reports "PCN 22/F/A/W/T," which means the PCN of 22 is based on the runway's flexible pavement with a high category subgrade, available with no tire pressure limit, and based on a technical evaluation. If the aircraft in the sample ACN chart uses high tire pressure, its gross weight to operate there will be limited to just over 75,000 lb. The PCN given is for the runway only. Proper trip planning requires further investigation.

If you are planning a trip to an airport that does not often receive aircraft very similar to yours, you will need to investigate the load carrying capability of the runways, taxiways and ramp areas. An airport directory is a good place to start.

Ideally, the airport directory will indicate a PCN, LCN/LCG, runway weight limit per leg, or an aircraft-specific weight limit based on landing gear configuration. You still need to determine if the taxiways and ramp areas are adequately stressed. For this information you may need to call the airport.

Similarly, if you cannot find pavement stress information, you should call the airport management office directly. Keep in mind that while the airport manager may respond, "Sure, we get airliners in here all the time," as already noted, your Gulfstream or Global could very well sink into pavement that can handle some airliners with ease.

You can safely assume an airport that is home to many of your aircraft type can handle yours. You don't have to worry about bringing a Falcon 900 into Teterboro Airport (TEB), but when you are heading to an airport that rarely sees anything larger than a twin Cessna, you should be careful. Call the airport, the FBO, and check it out on the Internet. You often can see video evidence of your aircraft at an airport by typing the aircraft and airport names into the YouTube search engine.

However, even when the airport has welcomed your airplane before, be alert as to where they tow it. Every few years I've seen an otherwise airworthy business jet, RJ or other type of aircraft stuck and unmoving, one wingtip on the ground because one of its main landing gear was parked too close to a drain hole or weakened area of tarmac. Finally, a big welcome notwithstanding, remember, the numbers are there for a reason, and nobody cares more about your airplane than you. B&CA