Why Does a Stearman Want to Go Left in Takeoff?

Posted on November 7, 2000 by Jim Stanfield

by the late, great Jack Davis

A common hangar flying topic after the Stearmans are safely put away is “having to hold right rudder on takeoff”. Everyone knows you have to do it and also has strong opinions on why it happens.

1. It’s the torque !!

2. It’s gyroscopic precession!!

3. It’s the dreaded “P” factor !!

4. It’s the Coriolis effect !!

5. It’s prop wash on the fin and rudder !! Helical Effect!!

Some research into this subject has come up with some interesting information and some good references to check it out on your own.

So here goes. This ought to get some letter responses going.

Torque

It would seem that since the engine and propeller are turning one way, the plane would try to roll the other way. And this is true to some degree due to propeller drag and inertia when the RPM is changed rapidly, such as hitting full power suddenly on a go-around. When increasing power smoothly and slowly on a

Stearman take off, it has little effect So it's not the torque.

Gyroscopic precession

This force is definitely there, but it only comes into play on takeoff during the time you are raising the tail from three point to level, and it isn't very much. The faster you raise the tail and the higher the rpm of the engine, the more prominent is the precession force turning you to the left. If you force the tail up early and quickly in the takeoff run, at low airspeeds, you will notice it more since the rudder isn't yet of much help. Here again, if you hit power rapidly for a go-around when the tail is down, as it comes up, it adds a left turning complication to the torque trying to roll you to the left.

Precession just isn't there in the early part of the takeoff roll when the tail is still on the ground. So precession isn't the culprit.

"P" Factor

This is the one that gets most of the blame. Partly because of the abstract name. This is the term for "asymmetric disk loading". That means that the downward moving blade of the propeller (the right hand one looking from the cockpit) produces more thrust than the upward moving one on the left side. But this is true only when the downward moving blade has a larger angle of attack, and this only happens when the vertical axis of the propeller plane is tilted back and not aligned with the relative wind. (When the tailwheel is on the ground or with a high angle of attack on climb.) This situation occurs with any tail dragger on takeoff, until the tail

comes up. When the plane is in a level attitude aligned with the relative airflow, there is no “P” Factor. However, “P” Factor forces, when they exist, are proportional to air speed, and the force to the left one feels during the first part of the takeoff run occurs when the airspeed is very low. So “P” Factor is there until you bring the tail up on takeoff, but it is negligible. Sorry!

Coriolis Effect

No, this was a ringer. But when you look it up it sounds plausible, and it can be used as a “coup de grace” in the hangar debate.

Helical Propwash

We are running out of options, so this better be it. Lloyd put this whole situation into play when he designed the Stearman with an engine that turns clockwise (from the cockpit) and a fin and rudder that points up from the fuselage instead of down. (Avoiding a longer tailwheel strut).

The propwash travels back from the propeller in a helical path going under the front part of the fuselage on the right, curving up on the left in the middle and over the top just where the fin and rudder have been placed. This propwash pressure strikes the fin and rudder on the left side pushing it to the right, causing the plane to try to turn left. You counteract this force first with right tailwheel steering, then when the tail comes up with right rudder.

The propwash effect occurs immediately and prominently on the

takeoff run as the RPM comes up and at low airspeeds where the fin and rudder aren't yet of much help. The tail wheel is effective, so keeping it down until you get more airflow over the rudder helps.

The helical propwash is still there and acting on the rudder and fin at all attitudes and airspeeds. At cruise, the fin and rudder are positioned with a cant so that it just offsets the left turning pressure of the helical propwash.

At High RPM and low airspeeds such as takeoff and climbout, right rudder is required. At lower RPM and higher airspeeds, such as descending, there is too much right fin correction and some left rudder is required.

Well there it is!!! It's the Helical Propwash that causes all that left turning force on a Stearman takeoff!!

A great reference available on the internet is a book written by John S. Denker titled "How it Flies" It can be found at the following web address: Http://www.monmouth.com/-jsd/how/htm
It covers all aspects of aerodynamics in easy to understand and colorful language. I recommend it highly. When it is published in hard copy, I will put in my order.