

Can You Stop Nose Gear Shimmy?

By Dave McFarlane



Nose gear shimmy is destructive and not normal, and yes, it can be stopped. Never allow any amount of nose gear shimmy to continue. The quicker you take action, the easier it will be to stop it.

"A Cessna nose wheel is supposed to shimmy."

"You can't really stop it."

"All the Cessnas do it."

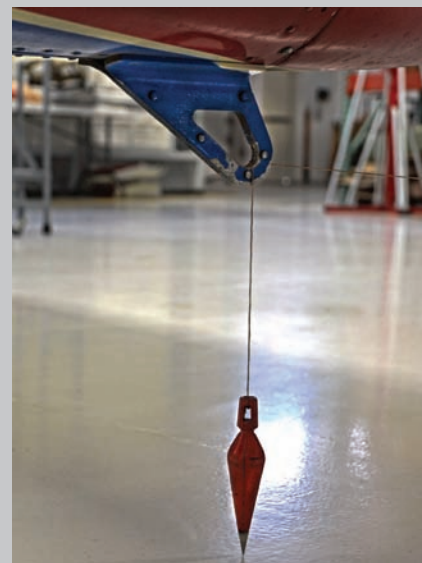
You have heard similar comments many times. My response is always the same question. "Did it shimmy when it was new?" I would like to share with you our experience in solving this problem.

I will bore you with the routine detail of what to look for and how to fix the mechanical issues that allow shimmy to get started in a minute. First, let's talk about the physics of nose gear shimmy. Years ago and after a lot of frustration by us and our customers and a lot of experimenting, we discovered what was causing our shimmy problems. We observed that uncorrectable nose gear shimmy seemed to only happen on hard surface runways and rarely on turf runways. Our customers reported that they could stop the shimmy by either taking weight off the nose gear with the elevator or applying the brakes putting more weight on the nose gear. It didn't seem logical that just changing the weight on the nose gear could affect shimmy since the airplane is designed to function with different loading on the nose gear and the weight change does not significantly change the nose gear geometry. We guessed that our customer's shimmy might have been stopped by the fact that the changing nose weight also changed the tire shape. We assumed that when the tire shape changes so does the contact profile of the tire to the runway. We had already done all of the normal things to perfect the nose gear and shimmy damping system rigging and mechanicals. The customer's tire seemed fine with no unusual wear patterns that could be detected. We still had shimmy! In frustration, an experiment was done by removing some tread rubber from

the tire. It did not seem to be a logical solution, but it worked. The shimmy went away!

There are some interesting dynamics going on during the shimmy action (besides trying to vibrate your airplane apart). When the nose tire is shimmying down the runway it is oscillating from pointing left and then pointing right many times per second while the airplane is going straight. The greater the tire angle diverges from straight ahead, the greater the shimmy inertia and energy. Since the oscillations are equal in divergence angle and time duration, the rubber on your tire is being scuffed in a uniform and distinct pattern that repeats itself each revolution of the tire. This wear pattern shape is directly related to the tire shape created by the amount of weight on the nose tire, the tire pressure, and the speed of the aircraft. The frequency of the shimmy is a derivative of these factors. You might have noticed a braking feel to the airplane when severe shimmying is happening. The braking is from the nose tire skidding sideways during the more extreme angle divergent portion of the shimmy cycle. Since shimmy generally takes place for a short time, the early stages of this wear pattern are microscopic and hard to detect visually or by feeling the tire tread by hand. After the first shimmy, the then created wear pattern tends to start the oscillating action when the airplane speed and nose gear weight matches the speed and weight that the airplane was traveling when the shimmy wear pattern was created. You might have noticed that shimmy starts at about the same landing or taxiing speed each time. The results are that the shimmy gets worse every time it happens even if the mechanical issues that let it start shimmying the first time have been corrected and the shimmy dampener is working and trying to do its job. The shimmy dampener simply is not strong enough to prevent shimmy when a nose tire has an established shimmy wear pattern in the tread. The hidden mystery to this problem is that early shimmy wear patterns in the tire are virtually un-detectable.

Drop a plumb bob to determine aircraft center line



One of the hardest parts of proper rigging is determining where the nose tire is straight ahead.

The method we use is to create an airplane center line by dropping a plumb bob from the center of the firewall to the ground (center can be determined from the rivet pattern or measuring from the motor mount attachments) and again dropping the plumb bob from the center of the tail tie down hook. Mark both of the plumb bob points on the shop floor and create a chalk line mark between the points. This is your airplane center line. Extend the center line forward as close to the nose tire as possible.

Place a straight 2x4 stud or a piece of straight angle iron against the side of the nose tire. Adjust the nose wheel and tire until the 2x4 is parallel with the airplane center line. Check your results by placing the 2x4 on the other side of the tire. The 2x4 acts as a tire angle multiplier giving you measurable results.

Parallelism can be checked by simply measuring the distance between the 2x4 and the chalk line in two places. Be sure not to move the airplane while you make your nose gear alignment adjustments.

Prevention Tips

The key to shimmy problems is to prevent shimmy from starting in the first place. You have to start with the routine stuff that is in the service manuals. The Cessna Pilots Association has a very good article on fixing the mechanical issues associated with nose shimmy on Cessna airplanes. Their Tech Note No. 001, Revision 004 dated 04/15/2010 does a good job of describing and illustrating the system and directing corrective repairs. This tech note seems to parallel the Cessna Service Information Letter SE84-21 on the same subject.

Continued on next page

Continued from previous page

1 The first step in preventing the problem is to look for any un-damped nose gear movement. This is motion of the nose tire without the shimmy dampener moving. Looseness in the nose gear system cannot be detected with the nose wheel off the ground unless the pressure is released from the nose strut. When you move the nose wheel right and then left, the shimmy dampener should also move. If there is any un-damped motion, tighten or replace the worn components such as the torque link bushings and spacers, the steering collar, and shimmy dampener attachments.

2 Remove the shimmy dampener attachments. Check the shimmy dampener for proper fluid and proper operation. Check the dampener for seal condition and excessive wear in the piston and dampener bore. The dampener shaft must have considerable resistance to motion when moved quickly but move easily when moved slowly.

3 Nose gear rigging is important to prevent shimmy. If the steering rods or bungees are biased, damaged, or holding improper tension, shimmy can be started. The aircraft service manuals do a good job of describing proper nose gear rigging procedures. Wheel bearings must be in good condition and properly adjusted.

4 Bad bearings or adjustments can allow un-damped tire movement. Tire balance is also critical for preventing shimmy as an out of balance tire puts cyclic centrifugal loads on the tire tread. Out of round tires will do the same thing. One of the objectives of preventing shimmy is to not have any type of cyclic loads going into the tire system.

Check the tire itself for casing shift or other damage as follows:

- Take the weight off the nose tire for a period of time to let the tire take its proper shape.
- Assure that the tire is inflated to the proper pressure for the aircraft.
- Spin the tire by hand and look for any significant lateral divergence (tire wobble) or vertical divergence (out of round). The tire must rotate true, but a little out of round is normal.
- If tire casing shape problems are detected, let the tire stabilize longer without weight. If that does not correct the problem, the only fix is to replace the tire.
- If the tire casing seems to run out true and the tire is determined to be airworthy in all aspects, remove the shimmy wear pattern in the tire tread.

How do you remove rubber on a good tire to get rid of this mysterious and evil tread wear pattern that nobody can see or feel? We use an electric disc grinder that is used in the weld shop for grinding welds and smoothing structural steel. Any large sanding disk power tool with a course grit disc or a belt sander would also work. There will be some rubber flying around the shop so this is a good job to do outside. Get someone else to do it if you have allergic reactions to latex or rubber products. Block the nose gear off the ground and give the tire time to stabilize its

5 shape without weight. Again assure that the tire has the correct inflation pressure. Touch the grinder to the tire at an angle that rotates the tire and removes rubber. With a little practice you will be able to control the tire rotational speed with small grinder angle adjustments. If you allow the tire to rotate too fast, very little rubber will be removed. If you allow the tire to rotate too slow, it is hard to remove the rubber evenly. Taxi speed tire rotation seems to work best. You can actually remove small "out of round" tire conditions by being steady with the grinder and allowing the grinder to work harder on the tire high spots. The grinder must be worked across the tire tread as evenly as you can. Never grind into the sidewall of the tire. You can feel advanced shimmy wear patterns before you start and they will take more work to remove than the patterns you cannot feel. The tire must feel smooth and even when you are done. Only experience will tell you how much rubber to remove. Be sure that the tire has good tread depth when you are finished, and verify that there is not any inadvertent damage to the tire. Clean up the rubber grindings and high speed taxi test the airplane. You will probably be smiling with the results. It is a good idea to re-balance the tire after grinding the tread and before returning the aircraft to service. If the test does fail, repeat the process. Yes, with a little patience, this shimmy beast can be tamed!



Use a belt sander to remove the shimmy wear pattern in the tread.



**Use wheel balancer P/N TOOL128 for 3/4" diameter axles or P/N TOOL129 for 1", 1 1/4", and 1 1/2" axles to check tire for proper balance (additional sizes available).
See page 263 for additional information.**