

# Comanche Gear Motor Retraction Load Tests (Jul 2009)

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There has been considerable chatter on the Delphi COF concerning the merits of replacing the main landing gear bungees on a more regular basis than the three-year requirement. The proponents claim less wear-and-tear on the gear motor/transmission, while other argue that the three-year requirement is sufficient.

Since I have not seen any published data on gear retraction load demands placed on the motor/transmission assembly, an experiment to obtain this data was in order.

A 3K-pound load cell having a digital readout was borrowed, and adapted to the gear retraction load adapter. The load cell was calibrated using four 25-pound lead shot bags incrementally. The load cell was accurate in each case within  $\frac{1}{2}$  pound.

In the first go-around, retraction increments were done with a ratcheting strap, and angular measurements of the apparatus were made with a digital protractor. See Figure 1 for the test configuration details.



*Figure 1 Gear Retraction Test using Load Cell and Ratcheting Strap*

Since the apparatus rotates with the rotating arm assembly, angles were measured at each of the details. This made collecting and resolving the data a bit of a math problem. Also, the ratchet wrench needed to be reset three times while the gear was partially retracted. Although good data

was collected but not all the way to the amber gear up light point, this method of collecting data was abandoned in search of a better technique.

A low cost 2 ton bottle jack was found at Harbor Freight and adapted to the load cell and to the airplane interface points. A detail of the unit is shown in Figure 2. The unit was installed to the existing clevis and rotating arm bushing. My thanks to Travis Taylor for the machine and welding work.



*Figure 2 Gear Retraction Test Setup using Hydraulic Jack and Load Cell*

The hydraulic setup was installed into the airplane, and load measurements made at discreet intervals. Unfortunately, the hydraulic jack only had a 4 inch stroke, and the full gear retraction swing at the rotating arm is 5 inches. The decision was made to size the apparatus length to measure only the last 4 inches of gear retraction stroke, since the gear motor/transmission load is greatest just prior to getting the amber up light.

From this starting position, the main gear is at maximum bungee stretch, which occurs when the main gear is 15 degrees from the vertical. The landing gear is fully retracted when the amber light comes on, and then the main gear wheel is 77 degrees from the vertical, as measured at the wheel rim.

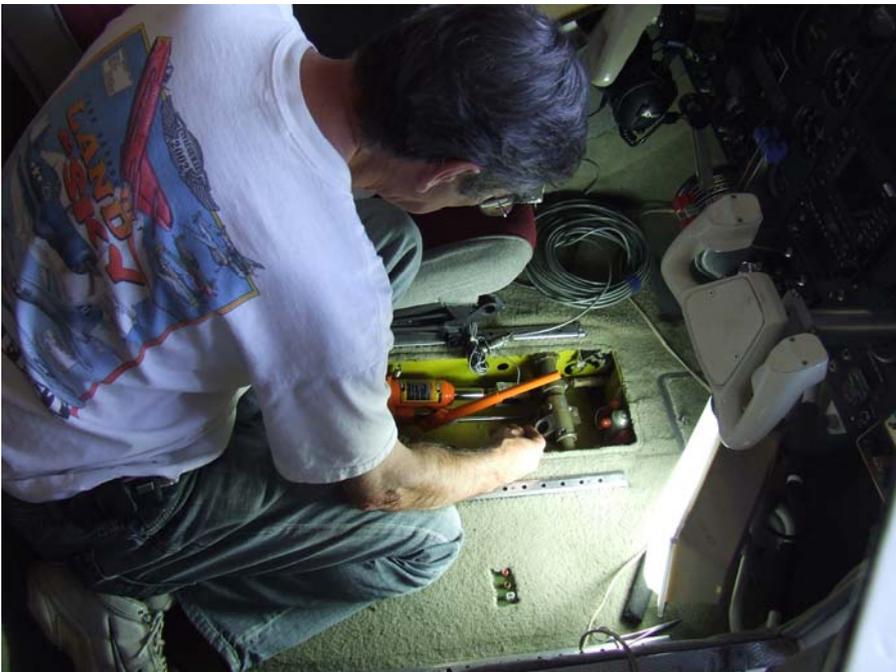
The tests were run three times for repeatability, with the bungees ON and OFF. The data was found to be repeatable and reliable, with no hysteresis in wheel angle or load. The installed bungees have been on the airplane approximately 9 months.

With Scott Myers able assistance with the digital protractor measuring the wheel angle, and myself pumping the bottle jack and taking data, the tests were done in an afternoon. Scott is shown in Figure 3, while I'm in the cabin in Figure 4. Scott also got the chance to remove/replace

the existing bungees using the Bogart tool. When done correctly, it can be done very quickly and efficiently.



*Figure 3 Scott Meyers measuring Main Gear angle.*

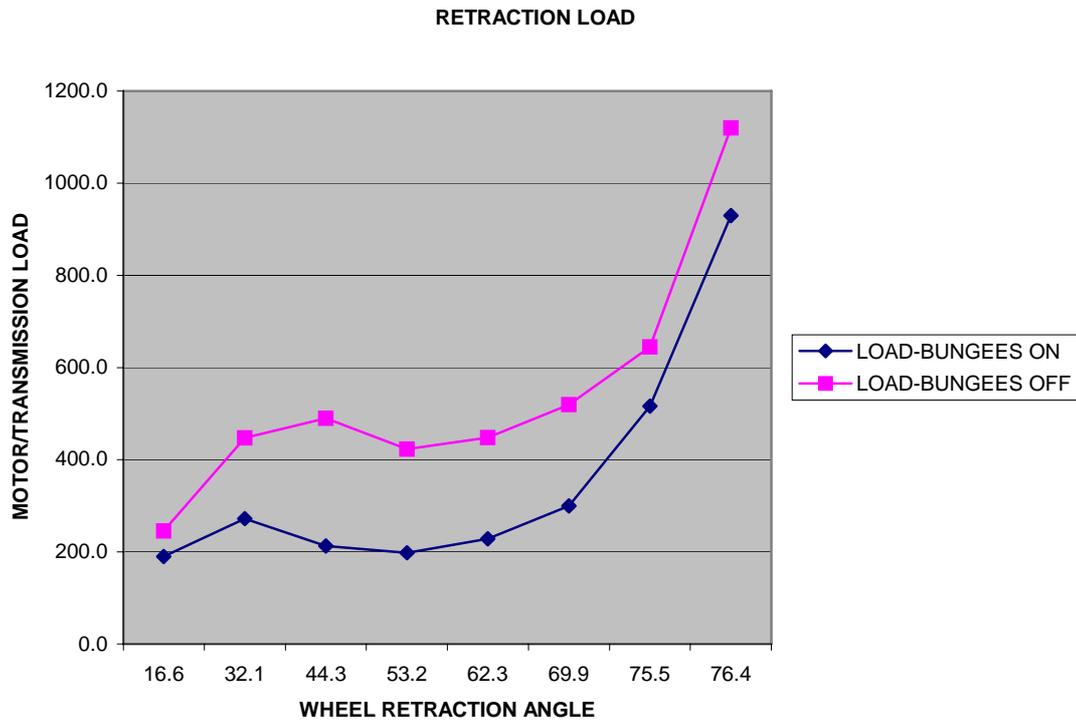


*Figure 4 Hans Neubert operating Bottle Jack (partially extended)*

The collected data was then summarized in an Excel spreadsheet, and plotted up for easier interpretation. Without the bungees installed, the load peak for full retraction is 190 pounds higher than with them installed. The gear motor/transmission is capable of a maximum load of

1000 pounds, and with bungees installed, the peak load is 930 pounds. There is only a small reserve capability remaining. With them off, the peak load is 1120 pounds. Although not tested, it is my speculation that the gear motor would not fully retract the gear with the bungees removed.

The results of the testing are shown in Figure 5, showing the load required at each main gear angle with the bungees on and off.



Ever since the 1000 hour landing gear DVD was made, I have recommended that the bungees be changed at every annual. The reasons are as follows:

- They are relatively inexpensive
- With the Bogart too, they install relatively easily
- They reduce the load on the gear motor/transmission

With new bungees at each annual, and the attended load reduction on the gear motor/transmission, the extension of life before overhaul on the motor/transmission is unknown. Given the significant expense of motor/transmission overhaul, I consider new bungees at annual to be a good trade-off.