

ACCIDENT

Aircraft Type and Registration:	Piper PA-28-151 Warrior, G-BCTF	
No & Type of Engines:	1 Lycoming O-320-E3D piston engine	
Year of Manufacture:	1974 (Serial no: 28-7515033)	
Date & Time (UTC):	25 March 2012 at 1225 hrs	
Location:	Durham Tees Valley Airport, North Yorkshire	
Type of Flight:	Training	
Persons on Board:	Crew - 2	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Right main landing gear leg separated from the wing	
Commander's Licence:	Commercial Pilot's Licence	
Commander's Age:	79 years	
Commander's Flying Experience:	21,760 hours (of which 5,000 were on type) Last 90 days - 40 hours Last 28 days - 16 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot and further investigation by the AAIB	

Synopsis

Following a normal landing the right main gear leg separated from its wing spar attachment. Two of the bolts which had secured the leg were found to have failed due to fatigue. The root cause of the fatigue failure could not be established.

History of the flight

The instructor and his student were carrying out takeoff and landing ('touch-and-go') practice using Runway 23. The wind was 8 kt from 200°. The student's first touch-and-go was normal, and the second touchdown was also normal. However, while the student applied power to take off again the instructor felt "a slight wobble" and immediately took control and closed the

throttle. The right wing dropped towards the ground and the aircraft slewed to the right, coming to rest on the runway. After shutting down the engine and electrics they vacated the aircraft.

Aircraft examination

The right main landing gear leg was found to have separated from its wing spar attachment (Figure 1). After the aircraft was recovered it was examined by an engineering organisation. They determined that the landing gear leg had separated due to failure of the four upper screws and four lower bolts (items 1 and 6 in Figure 2) which secured the leg to the right wing main spar.



Figure 1

G-BCTF resting on its right wing (inset: close-up of separated gear leg with wing supported)

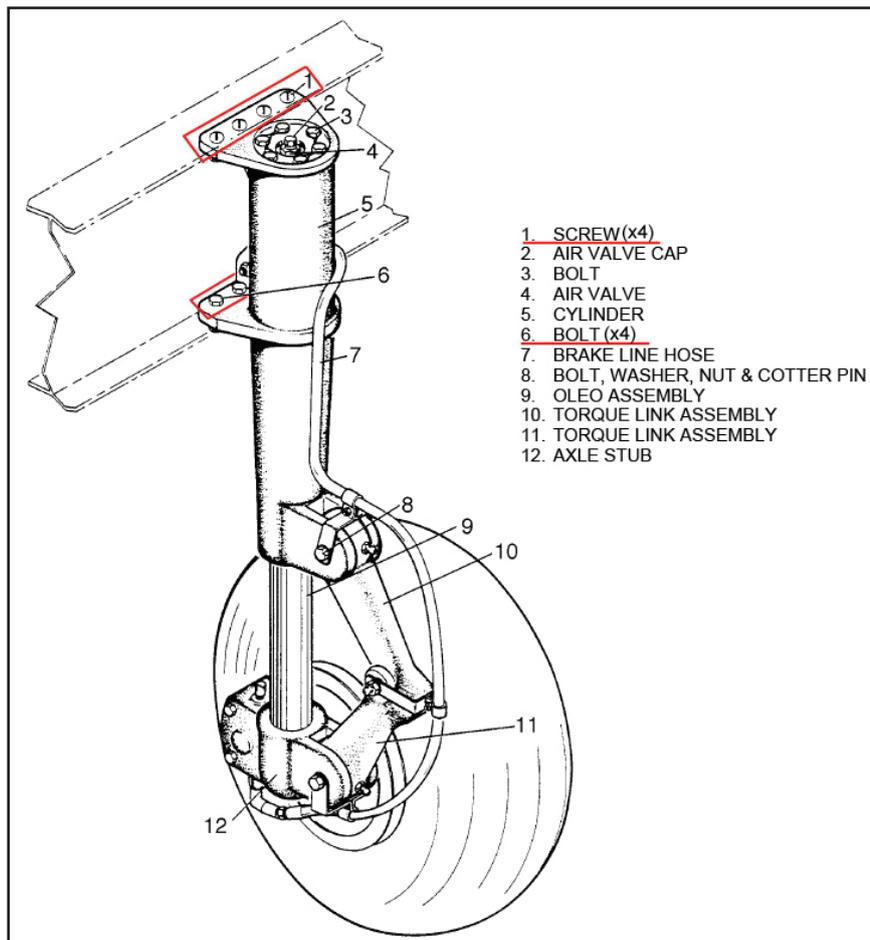


Figure 2

Diagram highlighting upper attachment screws and lower attachment bolts of the right main gear leg

Some of the failed parts were lost during the recovery. Three of the upper screws (AN525-416-R20) were recovered and were found to have failed in overload at the screw head. One lower bolt (AN4-11A) was recovered which had a corroded head and a fracture at its thread, but the fracture surface was smeared so it was not possible to determine its failure mechanism. Two further bolt/screw ends were recovered which had failed at the thread just above the nut (Figure 3). The AN4 bolts and the AN525 screws have the same 4/16” diameter and use the same nut in this location so it was not clear if these failed ends were from the upper or lower attachment, but as there are only four AN525 screws and three were already accounted for, one of these failed ends was part of a lower attachment bolt. Both of these bolt ends had a fracture surface consistent with a fatigue failure (Figure 4).

It was also evident that the nut on one of the bolt ends was not ‘in safety’ as there were no threads protruding beneath the nut (left nut in Figure 3).



Figure 3

Failed bolt ends that had evidence of fatigue on thread fracture surface

As part of the repair work the engineer decided to replace the attachment bolts on the left main gear leg as a precautionary measure. He recalled that one or two of the nuts on the lower attachment bolts were slightly loose by about half a turn. Unfortunately these bolts were not retained so they could not be measured for indications of stretch.

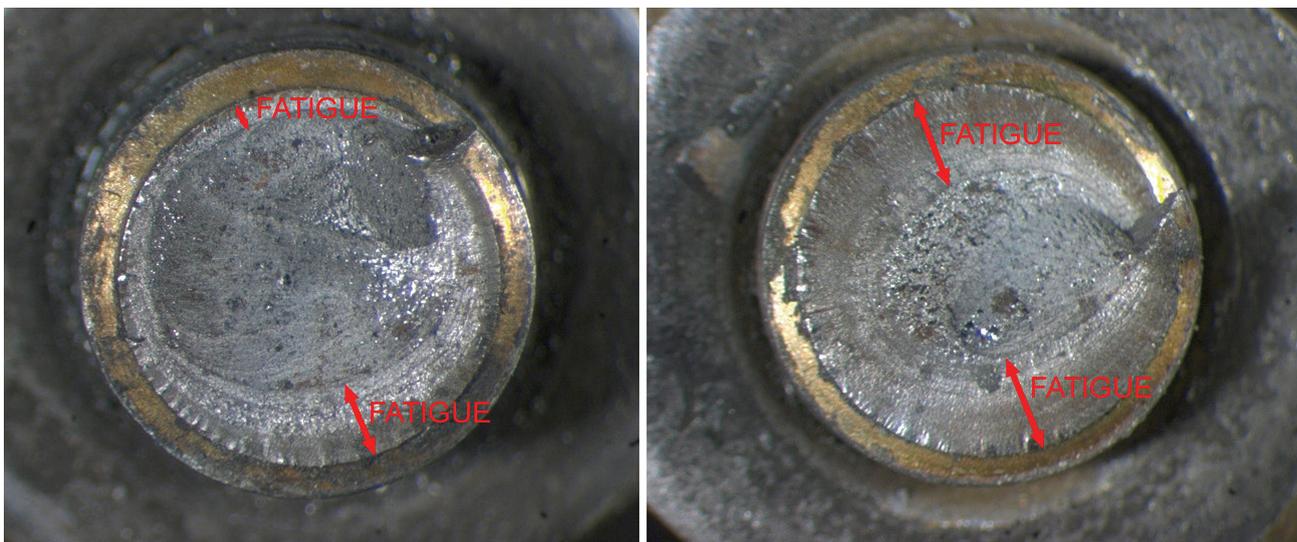


Figure 4

Fracture surfaces of the failed bolt ends showing fatigue features at the thread

Maintenance history

At the time of the accident on 25 March 2012 the aircraft had accumulated 10,634.4 hours. The aircraft's last annual inspection was completed on 24 February 2012, 35 hours prior to the accident. The aircraft manufacturer's maintenance schedule recommends that these bolts are inspected every 100 hours for 'condition and security'. The maintenance engineer stated that he inspected the gear attachment bolts and screws during the annual inspection and did not notice any anomalies. No torque check was carried out as none was required, but the engineer stated that he checked the gear leg for security.

The aircraft owner and the engineer recalled that about seven to ten years previously the right gear leg was replaced following a failure of the upper lug which secures the torque links. A record of this repair could not be found, but the engineer stated that the attachment bolts on the right gear leg had not been disturbed since that repair.

The maintenance engineer stated that he believed the bolt failures were a result of repetitive heavy landings. He also said that he had heard from another engineer who had encountered landing gear leg bolt failures on three separate occasions. He believed that the bolts should be replaced at a specified interval.

The aircraft owner stated that no heavy landings had been reported to the flying school.

Information from the aircraft manufacturer

The aircraft manufacturer was informed of the findings from this investigation and was asked if they were aware of similar previous failures. They performed a search of the US Federal Aviation Administration's 'Service Difficulty Reporting' (SDR) database, which contains

data back to 1995, and identified six discrepancy reports relating to fixed-gear PA-28 landing gear attachment bolts. These reports described failures of some of the lower and upper attachment bolts – most as a result of shear and one as a result of corrosion. None mentioned fatigue failures. Two of the reports recommended that the bolts be torque checked every 100 hours.

In light of the findings from G-BCTF the manufacturer was asked to consider adding a torque check to the maintenance schedule. The aircraft manufacturer responded that because there have only been six reports over the course of 18 years and they have manufactured over 30,000 PA-28 series fixed-gear aircraft, from 1961 to the present:

'The SDR data does not support changing the instructions for continued airworthiness with respect to these bolts.'

Analysis

The right landing gear leg separated from its wing attachment following a normal landing. All eight gear leg attachment bolt/screws were found to have failed although it was not possible to determine whether any had failed prior to the landing. The three recovered upper screws had failed as a result of overload. The two recovered bolt ends showed evidence of having failed due to fatigue. It was established by a process of elimination that at least one of these was part of a lower attachment bolt and, due to the similarities in failure modes, it is probable that they were both part of lower attachment bolts.

There was no evidence of corrosion on these fracture surfaces and the circumferential nature of the fatigue cracking indicated a combined tensile and bending load failure mode. Bending loads would have been

introduced if the bolts had been loose. The bolts had reportedly not been disturbed for more than seven years, so it was possible that loosening occurred as a result of bolt stretch caused by heavy landings. The fact that some of the lower attachment bolts on the left main gear leg were found loose would also support such a theory. It was also possible that the nuts had backed off, as evidenced by the nut that was found not to be 'in safety'. The bolt pattern does not allow for significant relative rotation between mating parts, so it is unlikely that the fasteners would see a torque in normal service that would cause these self-locking nuts to back off over time. The maintenance engineer considered that the nut not being 'in safety' was probably the result of an installation error with too many washers used.

The gear attachment bolts had been visually inspected 35 hours prior to the accident, but a visual inspection would not have detected a slight loosening or any cracking above the nut. However, a torque check of the nuts would have detected if the bolts had loosened due to stretch and were susceptible to a fatigue failure. The aircraft manufacturer was asked to consider whether such a torque check should be part of the recommended maintenance schedule, but they stated that, given the size of the PA-28 fleet, there was insufficient evidence of a problem to warrant such a change.