

No: 3/92

Ref: EW/G91/09/12

Category: 1c

Aircraft Type and Registration: Piper PA-34-200T Seneca II, G-BPCY

No & Type of Engines: 2 Continental TSIO-360-EB piston engines

Year of Manufacture: 1979

Date & Time (UTC): 17 September 1991 at 0940 hrs

Location: Compton Abbas Airfield, Wiltshire

Type of Flight: Private

Persons on Board: Crew - 1 Passengers - 1

Injuries: Crew - None Passengers - None

Nature of Damage: Propellers bent, engines shock loaded, nose landing gear, fuselage nose and left wing damaged

Commander's Licence: Commercial Pilot's Licence with Instructor rating

Commander's Age: 29 years

Commander's Flying Experience: 2,493 hours (of which 1,050 were on type)

Information Source: Aircraft Accident Report Form submitted by the pilot, examination by AAIB and the Materials & Structures Department of the DRA Aerospace Division, RAE, Farnborough and liaison with the CAA and the aircraft manufacturer's agent in the UK.

After completing two circuits during a PPL Group B training flight, the instructor simulated an engine failure after take-off, followed by a single-engined circuit and approach. On final approach the student selected the landing gear down. The instructor noted, and commented, that the landing gear had locked down with a louder noise than usual. A visual check as the aircraft approached the single-engine decision height confirmed, by the means of the mirror mounted on the inboard side of the left engine cowl, that the nose landing gear had extended. In the cockpit, the three green landing gear 'down-and-locked' lights had illuminated. The approach was continued and a normal landing was carried out by the student. Shortly after touch-down the nose landing gear retracted, causing extensive damage to the forward fuselage and both propellers. During the subsequent ground slide the aircraft slewed to the right. After the aircraft stopped, both occupants (who were uninjured) vacated the aircraft.

Before moving the aircraft from the runway, the main landing gears were inspected and found to be correctly locked-down. After towing the aircraft off the runway, the nose landing gear was made safe

in the extended position and the emergency landing gear lowering system was activated. Whilst this work was being carried out, the left main landing gear collapsed.

Subsequent examination of the nose landing gear showed that the bolt which had attached the forward end of the downlock link to the top of the nose landing gear leg had failed. The Piper part number for this bolt was 400-274 (AN7-35). The failed bolt and the downlock link were submitted to the Materials & Structures Department of the Defence Research Agency Aerospace Division at RAE, Farnborough for detailed examination. Their examination of the bolt concluded that it had failed in 'double-fatigue' (photograph No. 1), largely as a result of the growth of fatigue cracks from defects in the surface. The fatigue extended across the complete cross-section of the bolt. The defects in the surface were associated with decarburisation which had occurred during manufacture. It was concluded that the failure of the bolt had been strongly influenced by its substandard condition.

Similar bolts were removed from two other Piper PA 34 nose landing gears, one having achieved approximately 2500 hours and the other 120 hours. Both had similar manufacturer's markings on the bolt heads which were totally different from the markings on the head of the bolt that failed (photograph No. 2). Neither of these two bolts had any fatigue cracks, although the 2500 hour bolt had very heavy wear-induced 'grooving' in the area where the failure had occurred in the subject bolt. Hardness testing of the two intact bolts showed them to be considerably stronger than the failed bolt. It was not possible to establish the source of supply of the bolt that had failed. There was no record of this bolt having been replaced in the period since the aircraft was placed on the United Kingdom register in November 1988. The aircraft had accumulated a total of 3300 hours since manufacture.

The downlock link had a bronze bush fitted at the end which connected to the top of the nose landing gear leg. This bush, which was a 'press-fit' in the link, was found to be protruding from the inner face (photograph No. 3), *ie* the surface adjacent to the top of the nose landing gear leg, by approximately 2 mm. A build-up of a black, grease-like deposit on the protruding surface and the recessed face on the outer side indicated that the bush had probably been displaced for some time, *ie* the displacement had not occurred at the time that the bolt had failed. Further examination of the protruding end of the bush revealed a crack in its rim, and in the region of the crack there was a small lip on its outer diameter (photograph No. 4), suggesting that it had been locally deformed by pressure on its end face, although there was no evidence of associated damage on that face. Marks were apparent which extended part-way around the outer surface at various positions along the length of the bush. These marks appeared to be consistent with either a 'rebushing' operation, with some misalignment of the bush within the link when pressure had been applied to fit the bush, or with the bush having worked its way out of the downlock link whilst a bending load had been applied to the bolt. At the other end of the bush there was a clear impression of the bolt head on the end face and six matching 'indents' in the bore of the downlock link (photograph No. 5). These marks indicated that the bolt had been fitted without a washer under its hexagonal head and that it had been 'pulled' into the recess. On the inner face of the downlock link, around the bore, there was a faint annular marking with a diameter of approximately 25 mm, which was larger than the external diameter of the bush, suggesting that a washer/spacer had been present between the downlock link and the nose landing gear

leg at some time. However the only washer/spacer specified to be fitted in this location has an internal diameter of 19 mm, which just fits over the bolt.

Examination of the area of the bolt hole at the top of the nose landing gear leg, where the downlock link was attached, showed deformation of the steel and ovality of the hole (photograph No. 6) which had occurred over a period of time prior to the bolt failing. There was, however, no marking on the adjacent surface that could be associated with a washer or with contact with the protruding bush.

Examination of the aircraft's maintenance records showed that work had been carried out on the nose landing gear of the aircraft on a number of occasions since its importation into the UK from the USA. In February 1990, a new bush had been fitted to this bore of the downlock link. Subsequently there had been three occasions, March and April 1990 and January 1991, when the downlock link/nose landing gear leg bolt would have been removed to enable maintenance work to be carried out.

Another Piper PA 34 200T aircraft which had been maintained by the same maintenance organisation was examined and the downlock link/nose landing gear leg bolt removed. It was found to be correctly assembled except that there was no washer fitted under the head of the bolt. The bolt had been replaced by that maintenance organisation in October 1990. The Maintenance Manual and the Illustrated Parts Catalogue for this model, the Piper PA 34 200T, were found to give no specific instructions or guidance regarding the location of washers/spacers when assembling this bolt. However it was found that guidance was given, in pictorial form, on the assembly of this bolt in the Illustrated Parts Catalogue for the Piper PA 34 200.

The reason for the displacement of the bush was unclear. The appearance of the damage to the protruding end, *ie* cracking, local deformation and marks on the outer surface, was consistent with difficulties having been experienced during the fitting operation of the bush or by the bush working its way out of the downlock link during service. The faint annular marking on the inner face of the downlock link suggested that a washer may have been present at some time, although the size of the mark was not consistent with that of the washer that should have been used in this assembly, and there was no similar evidence on the adjacent face of the nose landing gear leg. The manner in which the bolt head had pulled into the bore of the downlock link, as a consequence of the absence of a washer in that position, appeared to confirm that the bush had been protruding at the time of the last assembly. The only other conceivable possibility was that one or two washers had been fitted at some time between the downlock link and the nose landing gear leg and that their internal diameter was large enough to allow them to fit over the bush, such that the bush could then be drawn through during tightening of the nut. However, in order for this to have occurred the bush and the washers would have had to be accurately aligned when assembled in the horizontal position and this would have been extremely difficult. The evidence of the build-up of a grease-like deposit on the protruding surface indicated that these washers had not been fitted during the last occasion upon which the bolt had been fitted.

With regard to the fracture of the bolt, which had occurred close to the interface between the downlock link and the nose landing gear leg, it is possible that although the bolt was clearly defective and therefore susceptible to fatigue damage, its failure could have been assisted by the increased bending loads which would have been introduced by the offset between the downlock link and the nose landing gear leg resultant from the displacement of the bush. The ovality and deformation evident at the downlock link end of the bolt hole in the nose landing gear leg certainly suggested that incorrect loading of the bolt had occurred.

During the course of this investigation the manufacturer's agency company within the UK was consulted with regard to any known problems with the nose landing gear of this aircraft type. They reported that they had experienced a similar problem with a downlock link/nose landing gear leg bolt failing approximately two years previously, but that the failure had not resulted in an accident. As a result, this company had instigated a 2000 hour scrap life on the bolts fitted to their own fleet of Piper PA 34 aircraft. No Mandatory Occurrence Report (MOR) was raised because such reporting is not mandatory for aircraft below 2,300 kg.

As a result of the above findings, the following recommendations have been made to the CAA for them to address internationally through consultations with the Federal Aviation Administration (FAA):

92-10.

The CAA introduce a 'one-time' inspection be carried out on all Piper PA 34 aircraft to ensure that the specified washer is fitted to the downlock link/nose landing gear bolt; that such bolts have the correct head markings and the surface condition of their shanks is satisfactory.

92-11.

The CAA ensure that adequate instructions and guidance are given in the Piper PA34 200T Maintenance Manual and Illustrated Parts Catalogue to enable correct assembly of the downlock link/nose landing gear bolt.

92-12.

The CAA require that a suitable life be determined for downlock link/nose landing gear bolts on Piper aircraft.

92-13.

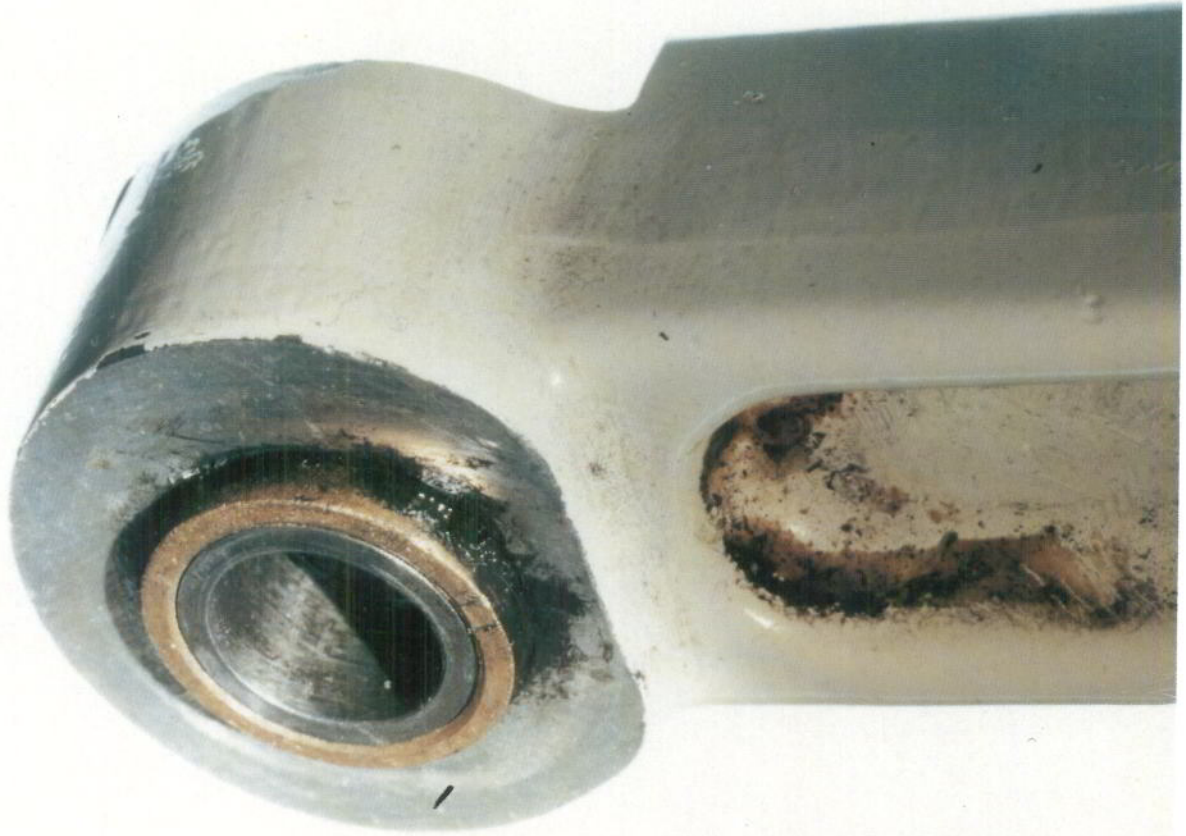
The CAA consider extension of the Mandatory Occurrence Reporting system to include aircraft under 2,300 kg maximum gross weight in the Public Transport and Aerial Work categories, and take measures aimed at ensuring that the service experience of operators and maintainers is fed back to the manufacturer and expeditiously shared with other relevant UK operators and maintainers. (This recommendation was also previously made following the investigation into Aerospatiale Twin Squirrel, G-WMPA, on 30 December 1990, AAIB Bulletin 12/91.)



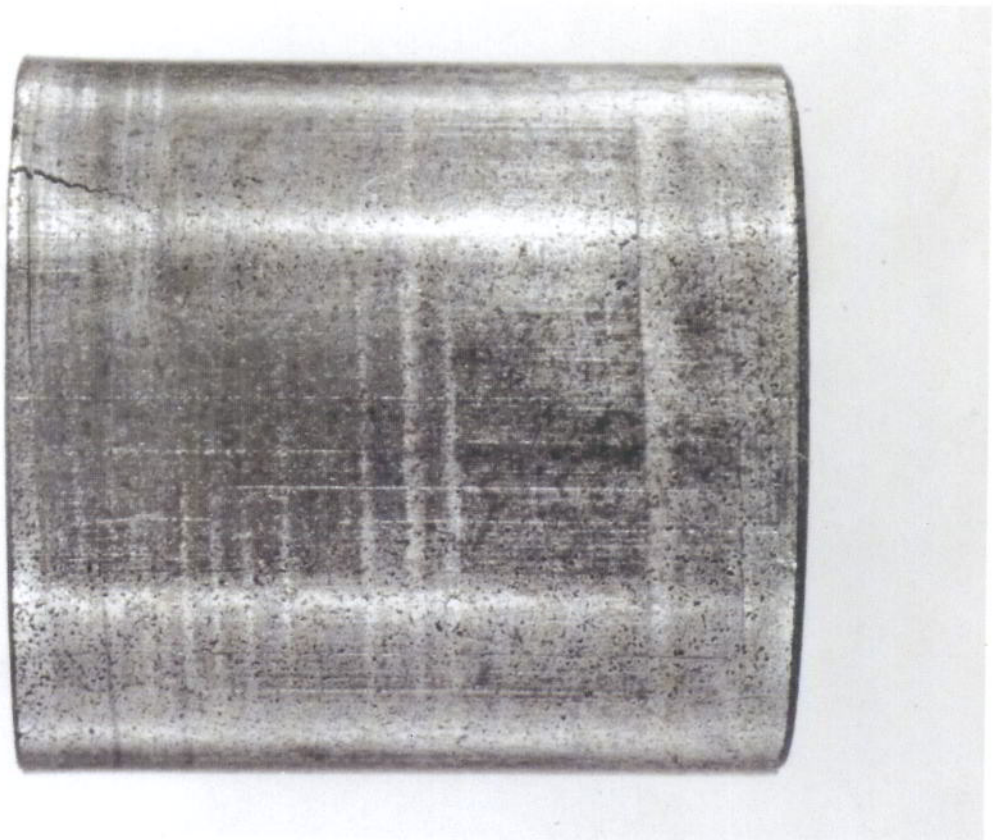
Photograph No. 1. Double fatigue failure of the bolt.



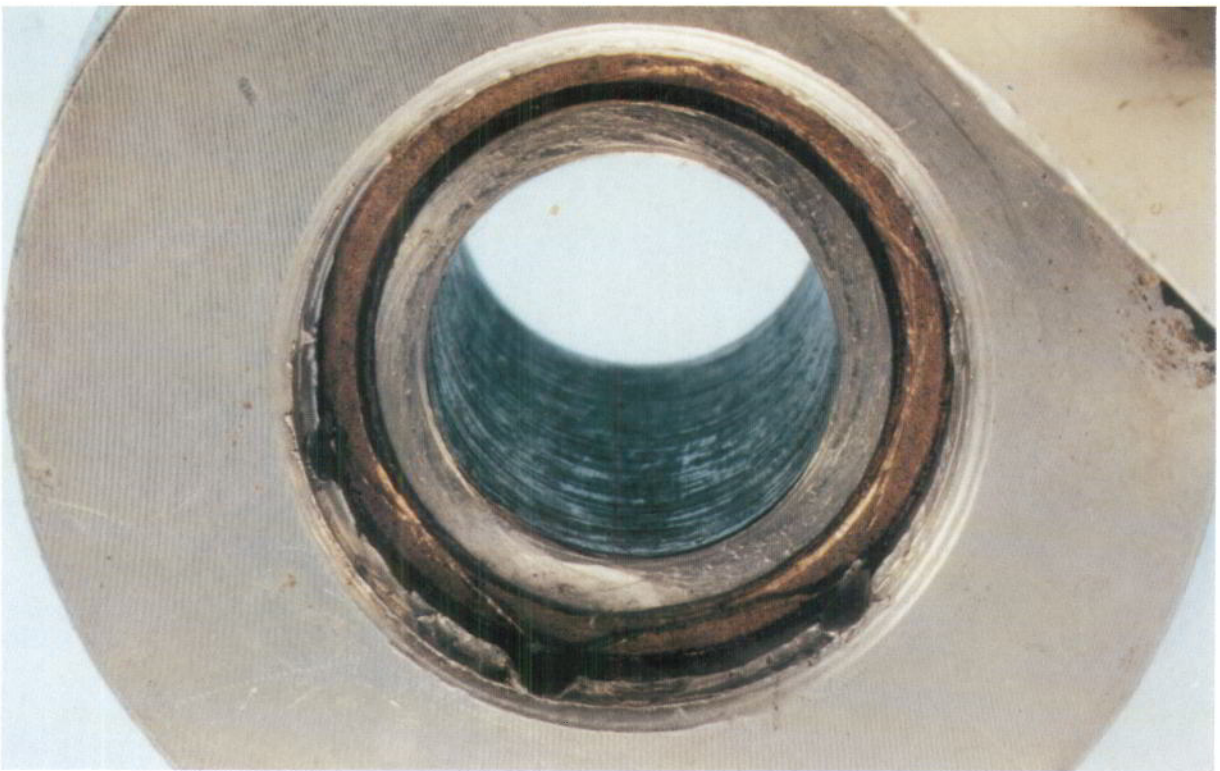
Photograph No. 2. Head of failed bolt (left) & "good" bolt (right).



Photograph No. 3. Protruding bush in the downlock link.



Photograph No. 4. Side view of the bush showing the crack and deformation lip.



Photograph No. 5. Bolt head markings in the downlock link and bush.



Photograph No. 6. Ovality of the bolt hole in the top of the nose landing gear leg.