Piper PA-28-161 Cherokee Warrior, G-BTBC

AAIB Bulletin No: 9/2004	Ref: EW/C2003/10/03	Category: 1.3
Aircraft Type and Registration:	Piper PA-28-161 Cherokee Warrior, G-BTBC	
No & Type of Engines:	1 Lycoming O-320-D3G piston engine	
Year of Manufacture:	1979	
Date & Time (UTC):	28 October 2003 at 1408 hrs	
Location:	Wellesbourne Mountford, Warwickshire	
Type of Flight	Training	
Persons on Board:	Crew - 2	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Minor to right main landing gear and flap	
Commander's Licence:	Airline Transport Pilot's Licence	
Commander's Age:	43 years	
Commander's Flying Experience:	9,672 hours (of which 645 were on type)	
	Last 90 days - 168 hours	
	Last 28 days - 40 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot and metallurgical examination of components	

Circumstances

The aircraft was being flown for the purpose of flight instructor training. The handling pilot was the instructor under training and he was seated in the right hand seat. Weather conditions were good with a surface wind of 240º/07 kt. The aircraft made a normal approach and landing on Runway 18, which has an asphalt surface with 912 metres (2,990 feet) landing distance available. During the landing roll the pilots noticed some shaking through the airframe, the right wing began to lower towards the runway surface and the aircraft veered to the right. The aircraft came to rest at the right side of the runway, after which shutdown checks were completed and the crew evacuated.

The right main wheel and leg had broken away from the underside of the wing but remained attached to the aircraft by the hydraulic brake pipe.

Examination of components

It was found that the lower torque link bolt had failed; - see the main landing gear details in Figure 1. This had allowed the wheel and axle assembly to pivot such that the wheel would have been pointing at approximately right angles to the direction of travel, thus causing drag forces sufficient to result in a bending overload failure of the leg.

Figure 1. View of principal components of main landing gear

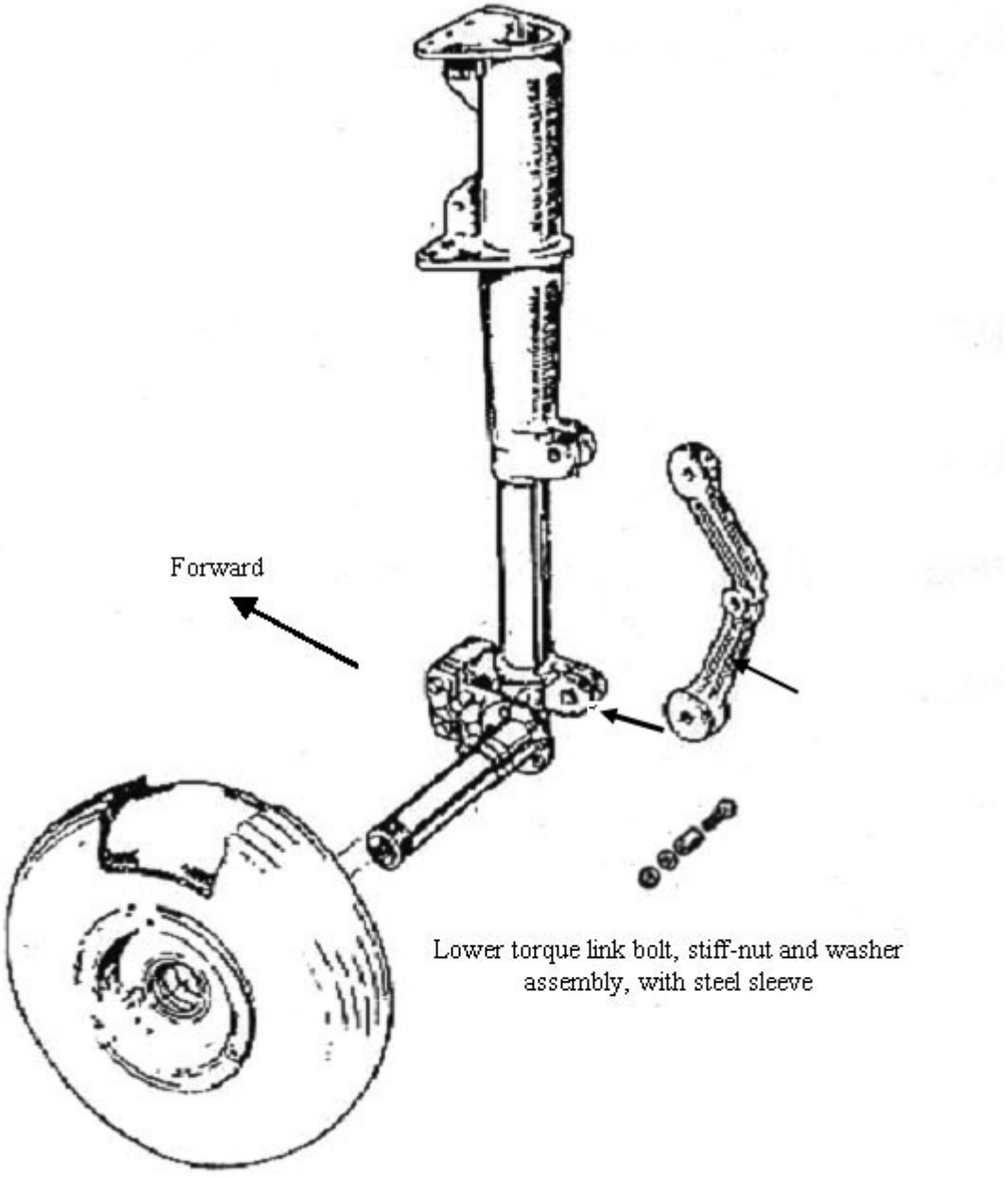

Figure 1 View of principal components of main landing gear
(For clarity, installation without wheel fairing is shown. When fairing is installed, a longer bolt is used, which has integral hexagonal spacer)

For reasons of clarity, Figure 1 shows the installation without a wheel fairing, which has a conventional bolt attaching the lower torque link to a fork on the axle assembly. In this case, where a fairing was installed, the 'bolt' in reality consisted of a steel shank, threaded at both ends, with a stiff-nut at one end and a castellated nut and split pin at the other. Integral with the shank was a hexagonal section, which functioned as a spacer. A steel sleeve had been located inside the bore of the lower torque link, and through which the bolt had passed. However this was not recovered after the accident. A number of washers and shims, designed to limit the lateral play of the lower link to 0.005 to 0.007 inches, were similarly not recovered. A photograph of the failed bolt is shown at Figure 2.

Figure 2. View of failed bolt

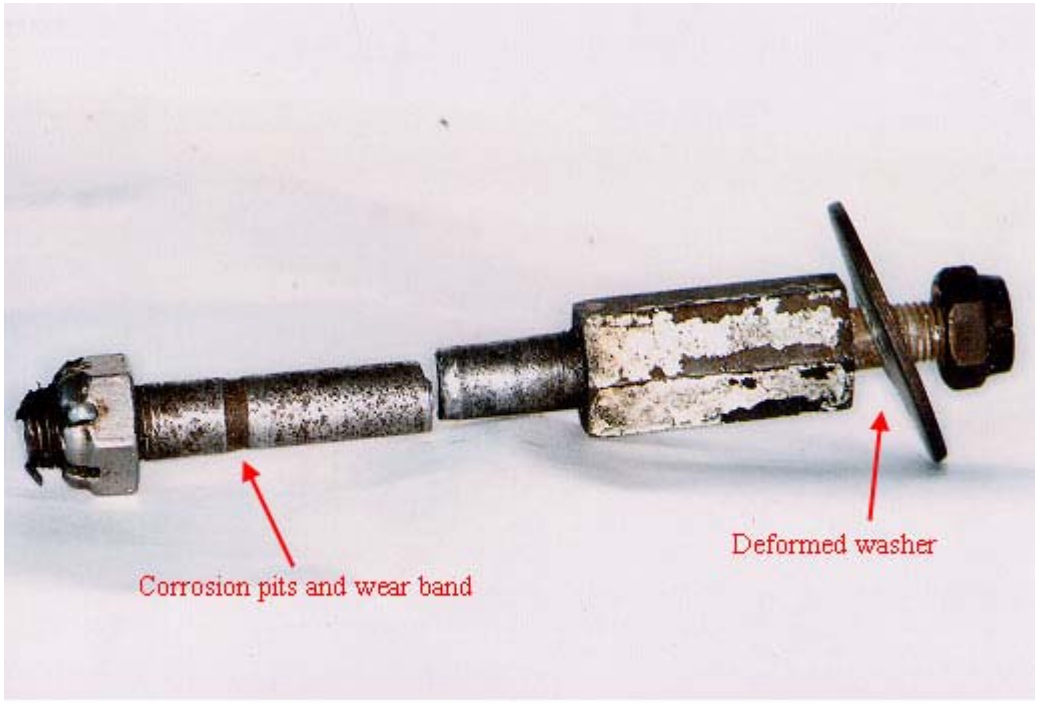

Photo: H T Consultants

Figure 2 View of failed bolt

The bolt and its related parts were subjected to a metallurgical examination and it was found that the bolt shank had fractured across its diameter as a result of a low cycle, reverse bending fatigue mechanism; - see the photograph of the fracture face at Figure 3. Approximately 80% of the fracture was due to fatigue, with multiple initiation sites around the circumference of the shank. The remainder of the failure was due to overload. Although the axial orientation of the bolt was not known, it is likely that the reverse bending process occurred about a vertical axis, ie parallel to the leg, as a result of oscillatory loads being transmitted from the wheel via the axle. Such loads could arise from wheel spin-up on touchdown and from braking.

Figure 3. View of fracture face showing fatigued areas above and below approximate region of overload

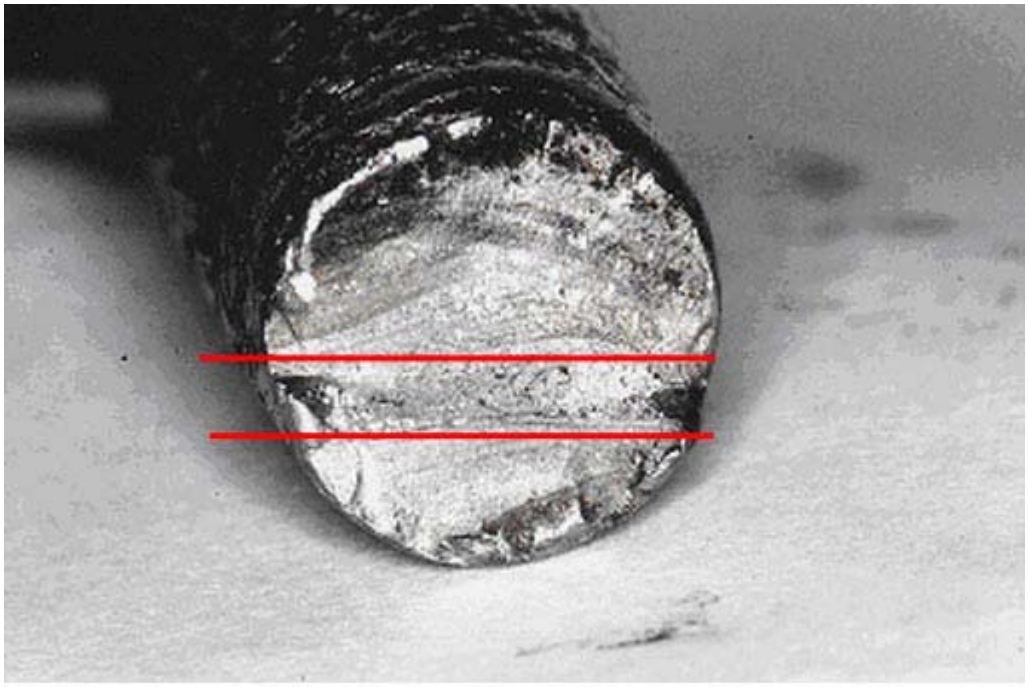

Photo: H T Consultants

Figure 3 View of fracture face showing fatigued areas above and below approximate region of overload

It can also be seen from the photographs that the portion of bolt shank containing the separation had been extensively attacked by pitting corrosion. The plane of separation was located at the interface between the lower torque link and the inner face of the inboard lug of the fork. A band of wear was apparent on the shank at a position corresponding to the outboard lug. The diameter in this region was 0.280 inches, compared with 0.290 inches for most of the rest of the shank. Close to the hexagonal section the shank diameter was 0.3125 inches.

Of particular interest was the large washer under the stiff-nut; this had suffered plastic deformation, indicating that the assembly had been over-tightened at some stage. Since this would have placed the bolt in tension, as well as preventing any rotation, it is considered that the bending fatigue resistance would have been reduced.

Assembly torque for the bolt is not specified, but according to the maintenance organisation for this aircraft, is generally assumed to be finger tight. The bolt is not subject to a finite life, but the maintenance schedule calls for an inspection of the area, including *".....torque links and bolts for condition and security"* every 100 flying hours. In addition, lubrication is required every 50 flying hours (the torque links are fitted with grease nipples). It is not known when the bolt was initially installed on the aircraft.

History

A number of accidents and incidents occurred during the 1970's, predominantly involving the centre bolt in the linkage, ie the one joining the upper and lower links. This prompted the aircraft manufacturer to issue Service Letter (SL) No 842 to advise that either an inspection schedule be implemented or modified parts be fitted to address the situation. A UK CAA Additional Airworthiness Directive (AAD) No 016-02-80, issued in February 1980, subsequently mandated the SL in the United Kingdom. Problems continued to occur and the AAD was later updated to Revision 1, since when there has been a marked reduction in failures. The measures that were adopted included magnetic particle inspections or visual inspections, depending on the type of bolt

embodied. However, the SL and the AAD only applied to the centre bolt, not to the lower attachment bolt that featured in the subject incident. It would thus seem sensible to recommend that a similar inspection regime to that required by AAD No 016-02-80 be implemented for the lower bolt.

Continuing airworthiness responsibilities

On 28 September 2003, responsibility for the airworthiness standards for most of the civil aircraft registered in the member states of the European Union (EU) passed to the European Aviation Safety Agency (EASA). This organisation has allocated the responsibility for the continuing airworthiness of non-EU built aircraft to the national airworthiness authorities of the various member states, with the result that Austria is now responsible for the PA-28 series. However, the shift in overall control of airworthiness from national authorities to a federal system has resulted in most National Mandatory Items (NMI's) generated by the member states being cancelled with effect from 28 September 2003. NMI's consist of AADS's, together with Additional Requirements for Import (ARI's) and Airworthiness Notices (AN's). Prior to 28 September 2003, there were more than 3,500 NMI's generated by the UK, of which the majority were AAD's.

Foreign (with respect to the UK) Airworthiness Directives are published by the CAA in CAP 473 (applicable to products and equipment of USA design) and CAP 474 (applicable to products and equipment of non-USA design). The following is an extract from the CAA's description of the changes to these publications that necessarily resulted from the transfer of responsibility to EASA:

> *The EASA policy for design standards is to adopt the Joint Aviation Authorities (JAA) type certification basis where one exists, and for all other products, the certification basis of the State of Design, together with the Airworthiness Directives issued by the State of Design. The European Commission (EC) working group that developed the policy recognised that assessments made and experience gained by EU Member States had led those states to issue Airworthiness Directives. Accordingly, the working group recommended that EASA should conduct a review of all products to determine whether the EASA reference type certificates need to be updated for safety reasons by issuing EASA Airworthiness Directives that have the same effect as those issued previously by Member States.*
>
> *To support EASA in this activity the CAA has conducted a comprehensive review of the UK Additional Airworthiness Directives to identify whether there are particular requirements that should be recommended to EASA for adoption across the EU. Having identified the particular requirements to be recommended to EASA for adoption, the CAA continues to apply these requirements in the UK under Article 10(1) of Regulation (EC) 1592/2002. Under the provisions of Article 10 the European Commission will decide, at some point in the future, whether each requirement should be adopted or not, and will then advise the CAA to retain, amend, or revoke those requirements.*
>
> *Note:- Article 10(1) of EC Regulation 1592/2002 makes a provision that: "...shall not prevent a Member State from reacting immediately to a safety problem which involves a product, person or organisation subject to the provisions of this Regulation".*

The UK CAA was the only authority of the member states to retain any NMI's under the provisions of Article 10; these amounted to approximately 170, mostly AAD's.

Most of the AAD's within the EU had originated from the UK CAA; there would thus be a significant burden placed on the other member states if they were required by EASA to implement them. This provided the rationale for the CAA review referred to above, in which they had to justify all those AAD's they proposed to retain. However, since the final decision will be taken by EASA, there is no guarantee that any of them will ultimately be retained. This effectively underscores the EASA policy of placing greater reliance for continued airworthiness on the states of design, which will continue to issue Airworthiness Directives.

The permanently cancelled AAD's included 016-02-80, with the result that maintenance organisations are no longer required to comply with it.

Summary, discussion and Safety Recommendations

The general condition of the failed bolt was poor, with the degree of corrosion pitting suggesting that inadequate lubrication had featured at some time in its (probably lengthy) history. The degree of wear that had occurred on the bolt shank was an additional indication of a lack of lubrication. The distortion of the washer suggested that the bolt had been over-tightened at some stage, which would have rendered it more susceptible to fatigue initiation. Finally, the nature of the installation does not readily lend itself to ease of inspection, as so little of the bolt surface is visible without disassembly. Access is even more difficult where wheel fairings are fitted.

The UK CAA were aware of a history of failures of the main landing gear centre torque link bolt and had taken measures, in the form of AAD No 016-02-80, to address the problem. The lower bolt is located only inches away from the centre bolt, and would also be expected to benefit from an improved inspection regime. It would therefore be logical to recommend that an inspection procedure be developed for this bolt, which would be similar in concept to UK CAA AAD No 016-02-80. However, such a recommendation is more difficult to make following the cancellation of this, together with most other AAD's.

Whilst some AAD's may safely be cancelled by reasons of obsolescence, many others, notwithstanding the CAA review, may still be relevant, and their cancellation raises issues far beyond the circumstances surrounding the incident to G-BTBC. AAD's are generally not made lightly, and in the case of No 016-02-80, has resulted in an improvement in the failure rate of the centre torque link bolt. It seems reasonable to suggest therefore, that there will be an increase in the number of occurrences if the AAD is no longer complied with.

As a result of this incident, the following Safety Recommendations are made:

Safety Recommendation 2004-20

It is recommended that the Federal Aviation Administration, (FAA), as certifying authority for the Piper PA-28 series of aircraft, mandate Piper Service Letter No 842, which called for an improved inspection procedure for the bolt attaching the upper and lower links in the main landing gear torque link assembly. It is further recommended that a similar inspection procedure should be mandated for the lower torque link bolt.

Safety Recommendation 2004-14

It is recommended that the European Aviation Safety Agency (EASA) review the torque linkage in PA-28 aircraft with fixed main landing gears, with a view to implementing an improved inspection procedure for the lower torque link bolt. It is additionally recommended that EASA implement a similar procedure for the centre bolt that reinstates the intent of the Civil Aviation Authority's (United Kingdom) Additional Airworthiness Directive No 016-02-80 Revision 1 which has now been cancelled.

Article 10(1) of EC Regulation 1592/2002 effectively allows Member States to take reasonable measures in response to a perceived safety issue. Any Airworthiness Directives resulting from such activity will be promulgated by EASA. However, the Agency is in its infancy, and some time will be needed in order to gain operational experience in matters of continuing airworthiness. In the light of this, the large-scale cancellation of AAD's may be regarded as premature. As a result, the following Safety Recommendation is also made:

Safety Recommendation 2004-15

Until such time as they gain experience in matters of continuing airworthiness, it is recommended that the European Aviation Safety Agency review the policy of cancellation of National Mandatory Items, including Additional Airworthiness Directives.