ACCIDENT

Aircraft Type and Registration:	Diamond Aircraft Industries DA42 Twin Star, G-SLCT
No & Type of Engines:	2 Thielert TAE 125-01 piston engines
Year of Manufacture:	2005
Date & Time (UTC):	3 June 2010 at 0900 hrs
Location:	Stapleford Airfield, Essex
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Aircraft extensively damaged
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	38 years
Commander's Flying Experience:	2,276 hours (of which 58 were on type) Last 90 days - 107 hours Last 28 days - 40 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and AAIB investigation

Synopsis

Despite cycling the landing gear several times, the right main gear remained in the retracted position and the pilot landed the aircraft on the nose and left main landing gear. The pilot and passenger were uninjured, but the aircraft was extensively damaged. The investigation established that the right landing gear jammed in the wheel well as a result of the failure of a trunnion, which connected the landing gear damper to the wheel trailing arm. The failure was caused by stress corrosion cracking. Three Safety Recommendations were made to the aircraft manufacturer.

History of the flight

The pilot reported that on selecting the landing gear down during the approach to Cranfield, the gear unsafe light illuminated and the position indicator for the right main landing gear remained extinguished. The landing gear was cycled several times, but with the gear selected down the indications in the cockpit remained the same. The controller in the Tower confirmed, as the pilot flew down the runway, that the right main landing gear had not extended. The pilot elected to return to his home airfield at Stapleford and during the flight carried out a number of high g manoeuvres in an attempt to dislodge the landing gear. As this was unsuccessful, he undertook a number of touch-and-go landings at Stapleford, but to no avail. A landing was subsequently

made on Runway 22R; the pilot held the right wing up for as long as possible during the landing roll, whilst maintaining directional control with the rudder and latterly the brakes. The wing settled on the runway and when directional control was no longer effective, the aircraft yawed to the right before coming to rest in a field of crops, on a heading of approximately 270°. While the pilot and passenger were uninjured the aircraft was extensively damaged.

Damage to the aircraft

The aircraft was recovered and examined by the operator's maintenance organisation who advised the AAIB that the trunnion (Part No D60-3217-23-51) that connected the landing gear damper to the wheel trailing arm on the right landing gear leg had failed, Figure 1. This allowed the trailing arm to hang lower than normal, causing the landing gear to foul on the inside of the wheel well and prevented it from extending.

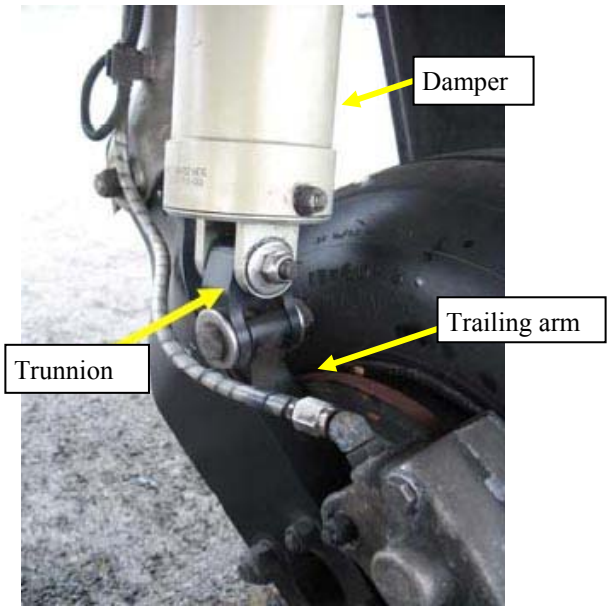

Figure 1

Location of failed trunnion on right landing gear

Stress corrosion cracking

Stress corrosion cracking (SCC) propagates along the grain boundaries in a metal and occurs when it is subjected to a sustained tensile load in a corrosive environment. SCC can be controlled by the use of corrosion prevention measures, minimising stress concentrations and using a combination of materials less susceptible to corrosion and SCC.

Examination of landing gear trunnions

General

The trunnions from the left and right landing gear assemblies were examined by a metallurgist at QinetiQ. The trunnions had been manufactured from aluminium alloy, specification 3.4365.71, which had been anodised to improve wear and corrosion resistance.

Trunnion from right landing gear

Failure of the right trunnion had occurred as a result of a fracture running along the 14 mm bore through which the attachment bolt that connects the trunnion to the damper was fitted. A section from this part of the trunnion, approximately 5 mm wide, had broken away and was not recovered from the accident site, Figure 2.

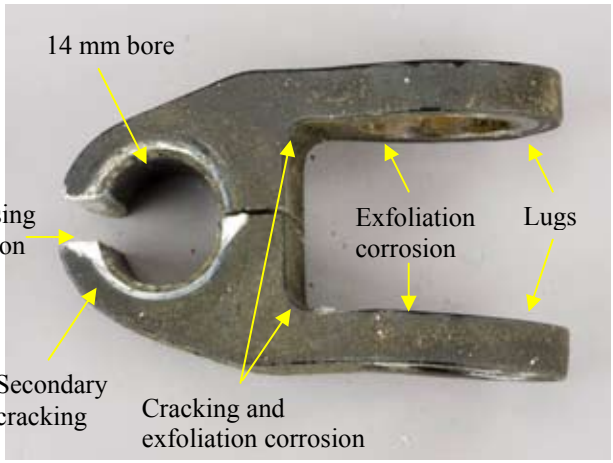

Figure 2

Damage to right trunnion

There was also evidence of secondary cracking and corrosion pits on the inside of the bore, with one corrosion pit located on the fracture face of the bore. The secondary cracking which was associated with damage to the anodised layer, had progressed along the exposed grain boundaries to depths of approximately 2.5 mm and was indicative of SCC.

The trunnion had suffered extensively from exfoliation corrosion on the inner and outer faces of both lugs, Figure 3, to a depth of 4.8 mm. Cracking and exfoliation corrosion to a depth of 1.6 mm was also found along the inner radius at the base of both lugs, Figure 4.

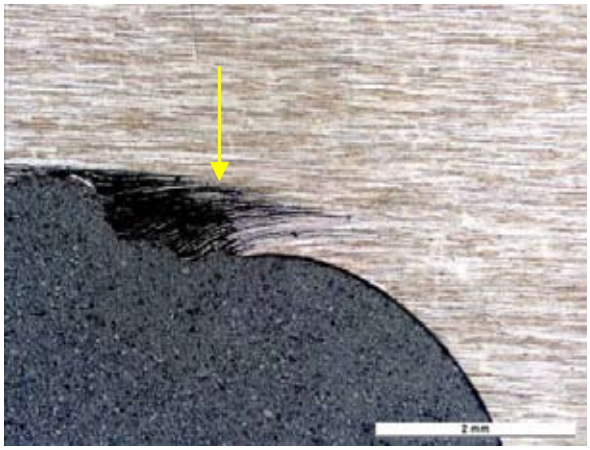

Figure 3

Exfoliation corrosion

Figure 4

Cracking at base of lugs

The bush (Part No BU1-18-10-0342) that fits into the lugs and the fitting on the landing gear trailing arm, Figure 5, had suffered from corrosion damage which appeared to be confined to the surface and did not penetrate the section, or show any evidence of pitting. There was no evidence of wear or gross loss of material. The bolt, which is fitted in the bush, was assessed as being in relatively good condition with no evidence of corrosion or damage.

Figure 5

Condition of bush

The metallurgist concluded that the failure of the right trunnion was as a result of SCC, which started in the 14 mm bore where the protective anodising had been damaged. Movement of the attachment bolt in the bore might have resulted in surface damage which compromised the anodised layer and accelerated the onset of SCC. The metallurgist also commented that the material from which the trunnion was manufactured is known to be susceptible to SSC, particularly when, as in this case, the component has been machined from plate stock or a forging resulting in exposed grain boundaries.

Trunnion from left landing gear

Examination of the left trunnion revealed evidence of exfoliation corrosion around both lugs. There was no

evidence of cracking either at the base of the lugs or within the 14 mm bore.

Previous occurrences

The aircraft manufacturer advised the AAIB that they were aware of corrosion occurring on the landing gear assembly and over the previous three years had inspected 550 aircraft and found 13 occurrences of damage to the trunnions. However, this was the first occasion that a failure had occurred in-flight.

As a result of these findings the aircraft manufacturer took the following actions:

- A temporary revision to the Aircraft Maintenance Manual (AMM-TR-MAM-42-368) detailing the anti-corrosion coatings to apply to the aircraft was issued on 14 July 2009.

- A Service Information letter (SI-42-127) was issued on 11 December 2009 advising operators of new anti-corrosion methods that had been incorporated in the AMM.

- A Mandatory Service Bulletin (MSB 42-088) was issued two weeks after this accident, on 23 June 2010, requiring the trunnions that connect the landing gear damper to the wheel trailing arm to be inspected for cracks within the next 20 flight hours and then at every 100 hour maintenance inspection. The MSB only required the joint to be disassembled if there was doubt about its condition.

Analysis

Examination of the trunnion on the right landing gear assembly revealed that it failed as a result of SCC along the inner face of the 14 mm bore. Stress corrosion cracking requires a metal to be subject to a sustained tensile load in a corrosive environment. The trunnions are manufactured from an aluminium alloy that is known to be particularly susceptible to SCC. Moreover the location of the trunnions results in their exposure to moisture and dirt thrown up from the main wheels. While the left and the right trunnion had been damaged by exfoliation corrosion, it is most probable that the SCC in the right trunnion started from a corrosion pit in the 14 mm bore caused by galvanic corrosion between the attachment bolt and the sides of the bore where the anodised layer had worn away.

The aircraft manufacturer had taken action to inspect the trunnions for cracking and corrosion, and introduced a number of anti-corrosion methods. However, these measures do not require the trunnion assembly to be dismantled; consequently, the current actions would not have identified any damage in the 14 mm bore, cracking at the base of the lugs or corrosion on the bush. Therefore, the following Safety Recommendations are made to the aircraft manufacturer:

Safety Recommendation 2010-066

It is recommended that Diamond Aircraft Industries consider issuing a Mandatory Service Bulletin for the trunnions (Part No D60-3217-23-51) on the main landing gear fitted to DA42 and DA42M aircraft to be removed, disassembled and inspected for corrosion and cracking.

Safety Recommendation 2010-067

It is recommended that Diamond Aircraft Industries review their instructions for the inspection and lubrication of the trunnions (Part No D60-3217-23-51) on the main landing gear fitted to DA42 and DA42M aircraft with a view to reducing their susceptibility to corrosion and stress corrosion cracking.

Safety Recommendation 2010-068

It is recommended that Diamond Aircraft Industries review the design of the trunnions (Part No D60-3217-23-51) on the main landing gear fitted to DA42 and DA42M aircraft with a view to making the components less susceptible to stress corrosion cracking.