ACCIDENT

Aircraft Type and Registration:	Fokker F27-500 Friendship, G-BVOB
No & Type of Engines:	2 Rolls-Royce Dart 532-7 turbo prop engines
Category:	1.1
Year of Manufacture:	1968
Date & Time (UTC):	22 March 2005 at 1140 hrs
Location:	Runway 27, Guernsey Airport, Channel Islands
Type of Flight:	Public Transport (Cargo)
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to left landing gear, wheels and brakes
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	58 years
Commander's Flying Experience:	10,611 hours (of which 8,231 were on type) Last 90 days - 32 hours Last 28 days - 20 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and additional AAIB enquiries

Circumstances

Following an uneventful landing on Runway 27 at Guernsey, the aircraft executed a 180º turn to the left in order to back-track the runway, with the intention of vacating at the threshold. Having completed the turn the commander applied sufficient power for taxiing and immediately felt a violent shimmy/vibration from the left landing gear. Thinking that a tyre had burst, he slowed the aircraft and found that the problem disappeared. However, after covering a short distance ATC advised that they could see that the tyres were intact, but that the complete wheel assembly was moving back and forth. The aircraft was stopped, the Airfield Fire Service was called and the aircraft was shut down.

Subsequently, personnel from another operator's engineering organisation inspected the aircraft and found that the torque link centre bolt had failed, thus allowing the torque links to separate. This in turn had allowed the wheel assembly to castor about a vertical axis, resulting in damage to the tyres, wheel rims and brake components caused by the unsecured torque links. It had been the oscillatory castoring action that caused the vibration felt by the crew.

The head and shank of the failed torque link bolt was found on the runway, together with a castellated nut and debris from the wheels. The separated, threaded tail of the bolt, onto which the nut had attached, was not found.

Following essential repairs, which included the replacement of the wheel and brake assembly, the aircraft was cleared by the aircraft manufacturer for a ferry flight to the operator's base, where the left landing gear was removed for a thorough inspection. The recovered portion of the torque link bolt, together with the castellated nut, was sent to the AAIB for a metallurgical examination.

Examination of the torque link bolt

An illustration of the main landing gear torque link assembly is shown at Figure 1, where it can be seen that the centre torque link bolt is retained by the castellated nut together with a headed locking pin and a split pin. The last two items were also not recovered, and it was considered likely that, assuming they had been present at the time of the incident, they had remained with the missing portion of the bolt.

The bolt had failed at the run-out of the threaded section, and examination under a scanning electron microscope revealed the presence of ductile dimples, which are a characteristic of ductile overload, across the entire fracture surface. There was no evidence of progressive crack growth, such as fatigue, and there was no evidence of bending. It was concluded that the observed features were consistent with the failure occurring as a result of an axial tensile overload.

It was considered that one means of developing an excessive tensile overload could be if the nut had been turning relative to the bolt as a result of frictional forces (between the bearing surfaces of the individual components within the assembly, ie the nut, washers and torque links) each time the torque links compressed on landing. However, rotation of the nut could only be possible after shearing the locking pin. The lack of damage on the sides of the castellations suggested that such an event had not occurred, although of course it was not possible to confirm that the pin had been present prior to the this incident. Furthermore, the bearing face of the nut exhibited no evidence of witness marks that would indicate it had been turning relative to the face of the adjacent washer, (which was also not recovered). Whilst the washer could have turned relative to its bearing surface on the torque link, there was no such evidence on photographs of this item.

Inside the nut, the threads had been severely damaged, consistent with an axial load having been applied in a direction away from the head of the bolt. The metallurgical examination observed that although the crests of the threads had been flattened, they did not appear to have been stripped.

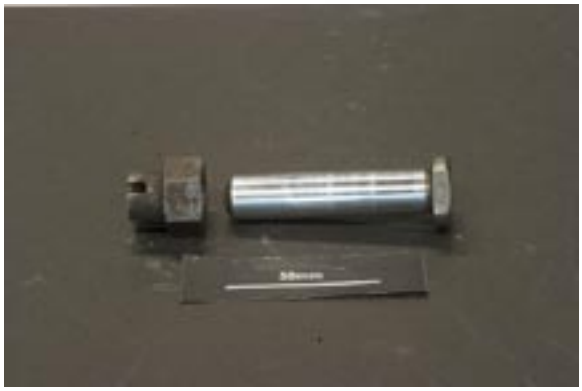
It was noted that the bottom of two opposite castellations showed evidence of witness marks that indicated that the locking pin had been present at least at some stage during the life of the nut.

It was not possible to conclude from the examination of the components the exact sequence of events that led to the failure of the bolt. It was particularly difficult to account for the absence of the detached bolt tail, as it would be expected to have remained in the nut, together with the locking pin. Assuming the latter had been intact at the time of the tensile failure, the bolt tail could only have exited via the top of the nut; it could not move in the opposite direction unless the locking pin had sheared. Either way, the threads in the nut must have been damaged to the extent that they were unable to retain the bolt.

Maintenance requirements

The operator's aircraft maintenance programme requires a periodic inspection of the main landing gear centre torque link bolt for correct torque loading. This occurs

Indentation of the locking pin in base of castellation



Nut and bolt portion, as found

Cross section of nut, showing thread damage

Figure 1

Main landing gear layout, showing details of torque link components

(Photos: QinetiQ)

every 'C' check, which is the earlier of 550 flight hours or eight months. The detailed instructions in the aircraft maintenance manual (AMM) calls for the removal of the split pin and shackle (locking) pin and the nut to be loosened. The nut should then be torque tightened to 60 lbf in, with a washer of appropriate thickness being used to obtain the correct locking position. A note states that: "An end float of the hinge pin is not allowed". The final instruction is to fit the locking pin and split pin.

The operator stated that the above check was last conducted on this aircraft on 8 August 2004.

Previous occurrences

The aircraft manufacturer was aware of one previous similar event, occurring in 1991, in which the torque links separated during taxiing for takeoff. It was found that the nut, which was not recovered, had stripped the threads off the bolt and sheared the locking pin, part of which was retained in the drilling in the bolt. The latter was otherwise intact and the investigation concluded that the cadmium plating on the bolt had deteriorated to the extent that corrosion had occurred in the threads, with consequent weakening.

Subsequent to the 1991 occurrence, the aircraft manufacturer recommended that those aircraft operated in high-humidity environments should periodically have the torque link centre bolts replaced, such as at each landing gear overhaul or landing gear shop visit. This advice was published in a 'Service Experience Digest'.

Discussions with the landing gear manufacturer following the incident involving G-BVOB suggested that any end float of the torque link bolt could result in a 'hammering' action on the threads as a result of the torque loads transmitted via the wheel assembly in service. It was considered that this may have been a feature of the 1991 incident, in which the threads were progressively weakened.

Other information

In considering the factors that could result in what was, to all intents and purposes, a simple overload failure of the bolt, it was decided to request an examination of the brake units from the left landing gear, since any defect that could cause them to snatch might cause such a failure. An examination was conducted by an overhaul agent, with no defects being found.

Discussion

The investigation was hampered by the fact that the detached portion of the bolt was not recovered; it was thus not possible to confirm that the locking pin was in position, or the extent of any damage. Despite the observation that the threads within the nut did not appear to be stripped, the very fact that the bolt was missing suggested that they were damaged to the extent they were no longer effective.

Despite the extensive service experience of this type of aircraft around the world, the only similar occurrence the aircraft manufacturer was aware of involved a corrosion process; this had not happened in this case. Examination of the available part of the bolt indicated a simple overload failure, such as might occur if a wheel struck a kerb or some other obstruction. An overload failure is essentially an unstable process, which implies that it occurred as a single event, as opposed to a series of 'partial' failures. This additionally implies that the failure occurred at the end of the landing roll, possibly as the aircraft was performing a 180º turn to the left, thus imposing maximum stress on the bolt. Although it seems unlikely that the failure occurred at an earlier time, this could not entirely be ruled out.