ACCIDENT

Aircraft Type and Registration:	Socata TB10 Tobago, G-OFLG
No & Type of Engines:	1 Lycoming O-360-A1AD piston engine
Year of Manufacture:	1979
Date & Time (UTC):	23 July 2005 at 1600 hrs
Location:	Derby Airfield, Derbyshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Serious) Passengers - 1 (Serious)
Nature of Damage:	Extensive damage
Commander's Licence:	Private Pilot's Licence
Commander's Age:	49 years
Commander's Flying Experience:	124 hours (of which 51 were on type) Last 90 days - 6 hours Last 28 days - 3 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot, local aircraft and engine examination and further enquiries by the AAIB

Synopsis

The pilot was attempting to take off from Runway 17 at Derby Airfield. The field performance was marginal and the aircraft failed to accelerate normally; it ran off the end of the grass runway at about 50 kt. The aircraft hit a hedge and ran into a ditch, causing extensive damage to the aircraft and serious injuries to the two occupants. Examination of the engine revealed that a maintenance error had allowed an induction air leak downstream of the carburettor. The investigation concluded that the slower than normal acceleration during takeoff was not recognised in time to safely abort the takeoff.

History of flight

The pilot, with his wife as passenger, had flown the aircraft to Derby Airfield from Gloucester (Staverton) Airport on the previous evening, and was in the process of taking off from Derby on the return journey when the accident occurred. Runway 17 was in use, which was 602 m long with a grass surface. There was no significant weather, the grass was dry and the surface wind was light and variable. The pilot had calculated the take-off distance to be 445 m, based on a 'take-off' flap setting and a rotate speed of 63 kt. With a take-off run available of 513 m, the pilot acknowledged that there was little margin for error but, at the time, he was confident that the takeoff could be carried out safely.

The pilot carried out a thorough external inspection of the aircraft. There had been a continuing problem with water in one of the fuel tanks and, although it was believed that the problem had been rectified, the pilot took the precaution of taking several fuel samples, which were all free of contamination. The total fuel on board was estimated to be 140 ltr, based on known consumption and a visual check of the fuel tanks.

The engine start and the taxi were normal. The pilot carried out his engine checks and pre-takeoff checks on the runway threshold; no adverse indications were noted. Takeoff power was set prior to brake release and the pilot noted that the propeller rpm was above 2,500 rpm, although manifold pressure was not noted. After a few seconds the pilot released the brakes and commenced the takeoff.

Initially, the aircraft appeared to the pilot to accelerate normally, although the runway surface was bumpier than expected. The pilot checked his instruments and indicated airspeed during the take-off roll; the airspeed was increasing normally but was still below rotation speed at that point. The pilot then realised that the aircraft was much further down the runway than he expected, and he once again checked the airspeed, which appeared to have stopped increasing. The bumpy surface was making it difficult to read the air speed indicator, but the pilot thought the speed had stabilised at about 50 kt. Realising that it would not be possible to stop in the runway length remaining, the pilot warned his passenger. In fact, his passenger was already aware that something was wrong and that the aircraft had not accelerated as it normally did. The pilot attempted to fly the aircraft off the ground as it approached a hedge at the runway end. However, the aircraft did not become airborne and struck the hedge, passing through it and across a track before coming to an abrupt halt a few metres further on. Several persons witnessed the takeoff. Those familiar with aircraft operations at Derby Airfield were of the opinion that the aircraft's acceleration was slower than normal, and that it achieved a speed of 40 to 50 kt, which it maintained until it struck the hedge. Some witnesses also thought that the engine note sounded 'flat'. The aircraft appeared to rotate to a take-off attitude as it approached the runway end, but the main wheels did not leave the ground.

The aircraft was extensively damaged in the accident but, although there was a small fuel leak, there was no fire. The pilot and passenger remained conscious but they were seriously injured. The passenger's seat had moved forward, off the seat rails, and the aircraft structure had failed in the region of the passenger's upper seat belt attachment point. The passenger was able to release her seat belt and fall through a hole in the forward fuselage where the structure had ruptured and the engine firewall had been forced upwards during the impact. The pilot attempted to secure the aircraft as best he could, but his door was jammed and he was unable to vacate the aircraft without the assistance of the airfield fire service, which had arrived on scene. It was later established that the pilot and his wife had suffered serious leg injuries.

Aircraft performance

The pilot had telephoned Derby Airfield the day before the accident to arrange his visit. He spoke to the aerodrome owner who expressed his opinion that the aircraft type may have been unsuitable for the airfield and cautioned the pilot about the relatively short field lengths available. The pilot indicated that he was aware of the field lengths and that he was satisfied that he could safely operate his aircraft at the airfield.

The aircraft flight manual gave take-off performance figures based on an aircraft at maximum take-off mass of

1,150 kg. The actual aircraft mass at takeoff was estimated to be 1,067 kg. Interpolation within the performance chart provided gave a take-off roll of 395 m, which was valid for a takeoff at 1,150 kg and taking into account the pressure altitude and an air temperature of 20ºC. The flight manual states that this figure must be increased by 10% to allow for the increased humidity conditions in the UK, and a further 20% to allow for takeoff on short grass. The take-off ground roll would therefore have been 521 m for an aircraft at maximum mass, lifting off at 63 kt. Runway 17 had a physical length of 602 m but, because of the hedges at each end, the published take-off run available (TORA) was 513 m.

In common with most aircraft in this category, the flight manual contained unfactored data, being the performance achieved by the manufacturer using a new aircraft and engine in ideal conditions and flown by a test pilot. The Civil Aviation Authority, through its 'General Aviation Safety Sense' leaflets, '*strongly recommends'* that the appropriate Public Transport safety factors be applied to all flights. This is in order to account for incorrect speeds or techniques, poor pilot recency, less than favourable conditions and normal aircraft and engine wear and tear. For takeoff the recommended safety factor is 1.33 and, had this figure been applied, the take-off run required would be increased to 694 m. The CAA also advises pilots to calculate a 'decision point' at which the aircraft can be stopped in the event of engine or other malfunctions such as low engine rpm, loss of airspeed indicator, or lack of acceleration.

Engine examination

The aircraft was powered by a Lycoming piston engine rated at 180 HP at 2,700 rpm, driving a constant speed propeller. The engine was examined by a local aircraft and engine maintenance organisation at the AAIB's request. The mechanical fuel pump was removed and found to be serviceable and, although some fuel lines had ruptured, there were no obvious signs of leakage. Examination of the induction air heat system confirmed that the hot air flap was attached and in the 'cold' position. The air filter was disrupted as was the trunking from the air inlet, but there was no signs of a blockage in the induction system.

The carburettor was removed and it was noted that all but one of the four retention nuts were only slightly more than finger tight. The carburettor mounting arrangement consisted of four studs which protruded from the engine sump, which incorporated an integral inlet duct, onto which the updraft carburettor was mounted. A gasket was used to form an airtight seal between the carburettor mounting flange and the corresponding machined face of the sump. Compression of the gasket often provides a degree of adhesion which makes removal of the carburettor difficult, though in the case of G-OFLG the carburettor separated without difficulty.

Examination of the top flange of the carburettor showed that a twisted double tail of lockwire, used to retain the nearby closure plug of the air metering jet, had become trapped between the carburettor flange and the bottom of the engine sump. The thickness of the lockwire was 0.69 mm greater than that of the gasket. Witness marks showed minor abrasion between the lockwire tail and the sump. The interior of the mounting holes in the carburettor flange showed thread marks which matched the thread of the attachment studs, indicating relative movement between the carburettor and engine sump mounting.

Aircraft examination

The aircraft suffered extensive damage in the accident; it was examined in situ by a local engineering company who reported their findings to the AAIB. The engine had

broken away and was inverted under the forward fuselage which was heavily disrupted. The engine firewall and main instrument panels had been forced upwards and to the left, and the cabin floor on the passenger's side had been forced downwards, creating the hole through which the passenger was able to evacuate. Movement of the centre consol to the left had contributed to the pilot's leg injuries. The main undercarriage had collapsed and the nose gear had collapsed and folded back beneath the fuselage. Although both wings were in approximate alignment, the right wing mainspar had sheared. The passenger's seat had collapsed downwards at its front end and a part of the aircraft structure had failed at the point where the upper seat belt fitting was attached to it. Although the equivalent structure on the pilot's side had not failed completely, there were visible signs of distress in the form of hairline cracks in the outer skin.

The aircraft had been certified in accordance with FAR 23 amendment 16, which required that the structure be designed to withstand the following inertial forces with an occupant weighing 170 lb (77 kg): upwards 3.0 g, sideways 1.5 g, forwards 9.0 g. For TB10 certification, load tests were performed on the structure with an occupant weighing 190 lb (86 kg) with no damage accruing to the structure or the seat belt assembly.

A mandatory service bulletin, number SB 10-103, had been introduced to ensure the integrity of the upper attachment of the front seat belts. The SB called for an inspection of the bolts and spacers of the upper attachment of the front belts and replacement where necessary, incorporating an upper attachment reinforcing kit and reconditioning of the seat belts. The Service Bulletin had been incorporated on G-OFLG. The failure of the structure was referred to Socata for analysis. The failure was not of the attachment point itself, but of the upper duct post to which the seat belt was attached. Socata concluded that the loads experienced in this accident exceeded those of the airworthiness requirements.

Aircraft history

The aircraft had been extensively damaged in a previous accident on 6 May 2001. Following that accident the aircraft was repaired, and in March 2002 the engine was overhauled, ′zero-timed′ and re-fitted, during which process the carburettor was also removed and re-fitted. In June 2003 the aircraft was acquired by a Gloucester based group, of which the accident pilot was one, and the aircraft was relocated to Gloucester Airport. There was no record of the carburettor having been disturbed since the engine had been overhauled.

Six weeks prior to the accident there was a reported case of loss of power in flight. After a long descent the engine failed to respond correctly and, although the pilot on that occasion reported that carburettor heat had been applied during the descent, it was felt that carburettor icing most closely fitted the symptoms, as power checks after landing were normal and no fault was found. There were no documented instances of a power loss during takeoff.

Conclusions

The trapped lockwire prevented proper seating of the carburettor, allowing an induction air leak downstream of the carburettor which may have reduced the available power during the take-off roll. As the carburettor had not been recently disturbed, the aircraft must have been operating with this latent defect for some time. Why it should have manifested itself so dramatically on this occasion is not clear, though the bumpy runway may have contributed in some way. It is possible that the three retention nuts on the carburettor, which were only slightly more than finger tight, may have been

disturbed during the significant disruption of the engine at impact.

The aircraft's performance was marginal. Applying the full corrections stipulated in the aircraft flight manual, the take-off run required exceeded the take-off run available by 8 m for an aircraft at maximum weight, though G-OFLG was estimated to have been 83 kg below that weight. Had the recommended take-off safety factor been applied, the take-off run required would have exceeded that available by a considerable margin. In his report, the pilot acknowledged that he had failed to recognise the lack of acceleration until the aircraft was at a point where there was insufficient runway remaining to safely abort the takeoff.