ACCIDENT

Aircraft Type and Registration:	Cessna 340A, N346DW	
No & Type of Engines:	2 Continental Motors Corp TCM TSIO-520-NB piston engines	
Year of Manufacture:	1979	
Date & Time (UTC):	15 July 2011 at 1156 hrs	
Location:	Fairoaks Airport, Surrey	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Damage to right main landing gear, right flap, right wingtip and right propeller, right engine shock-loaded	
Commander's Licence:	FAA Airline Transport Pilot's Licence	
Commander's Age:	72 years	
Commander's Flying Experience:	1,750 hours (of which 250 were on type) Last 90 days - 50 hours Last 28 days - 25 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

Synopsis

During the landing roll, the aircraft's right main landing gear retracted and the aircraft departed from the right side of the paved runway, damaging the aircraft. The damaged sustained by the landing gear components was consistent with the right main landing gear side brace folding, as weight was transferred onto the right main landing gear during the landing. The cause of the landing gear collapse was not positively identified.

History of the flight

Following maintenance, the pilot flew the aircraft from the airfield where the maintenance organisation was based to Dunsfold Aerodrome and he described the landing there as normal, with no reported defects relating to the landing gear. Nine days after this post-maintenance flight, the aircraft operated a private flight from Dunsfold Aerodrome to Fairoaks Airport, and the pilot reported that the landing gear retracted normally following takeoff from Dunsfold. At 2 nm on final approach to Runway 24 at Fairoaks Airport, the pilot selected the landing gear lever to DOWN and later recalled that the landing gear deployed normally, with three green DOWN lights illuminated. The pilot described the touchdown as normal, as did an AFISO who observed the landing from the control tower. As the aircraft settled onto its landing gear the right main landing gear collapsed, causing the right propeller and right wingtip to strike the runway. The aircraft veered off the right side of the paved runway, onto the grass, and came to rest on a heading of 040°M (Figure 1). The pilot was not injured in the accident and left the aircraft using the rear cabin entry door.

The weather conditions at the time the aircraft landed were described as being fair, with a 10 kt surface wind from 270°M and visibility of more than 10 km. The surface temperature was +22°C and the runway surface was dry.

Aircraft information

The Cessna 340A is a pressurised, twin-engined aircraft, equipped with retractable tricycle landing gear. The aircraft has a maximum certificated landing weight of 2,719 kg and the estimated landing weight of the aircraft at Fairoaks Airport was calculated to be

2,418 kg, with the centre of gravity within permitted limits. The aircraft's maximum demonstrated crosswind component is 23 kt.

The landing gear retraction system is powered by an electric motor that drives, via a reduction gearbox, a series of rods, torque-tubes and bellcranks that move the landing gear legs. The main landing gear is held in the 'down and locked' position by a folding side brace. A downlock link, driven by a bellcrank, applies force to the side brace to keep it in an over-centre position when the landing gear is down (Figure 2).

When the main landing gear leg is down and locked, the downlock link and bellcrank should be in an over-centre position, to prevent the side brace from folding. A microswitch, mounted to the downlock link, closes when it is over-centre and illuminates the green DOWN instrument panel light for that landing gear leg.



Figure 1 The aircraft following the right landing gear collapse



Figure 2

Schematic of the right main landing gear downlock mechanism, showing direction of motion as the landing gear locks down

Aircraft damage

The aircraft sustained damage to its right wingtip and right flap as a result of the landing gear collapse, in addition to damage to the right propeller and shock-loading of the right engine. The right landing gear was inspected and it was apparent that the downlock link had separated from the lower side brace due to fracture of the downlock link adjusting screw (Figure 3). Additionally, the forward lug on the upper landing gear strut, at its attachment to the bellcrank pivot bolt, had broken off and the fracture surface was dull with a rough texture, indicative of tensile overload. The bellcrank pivot bolt had sheared, such that the bellcrank was no longer attached to the landing gear strut. The right main landing gear microswitch, mounted on the downlock link (Figure 4), was electrically tested and found to function correctly when the switch contacts were closed. However, due to the deformation of the microswitch mounting bracket sustained during the accident, it was not possible to determine the pre-accident alignment of the microswitch lever with respect to the bellcrank.

Maintenance history

The aircraft underwent an annual maintenance inspection between February and June 2011, before being released to service on 29 June 2011; the accident at Fairoaks Airport occurred on the second flight following this maintenance inspection. As the aircraft



Figure 3 Location of right main landing gear leg broken components

is US-registered, maintenance performed must be in accordance with the requirements of FAR Part 43 *'Maintenance, Preventative Maintenance, Rebuilding and Alterations'*, which in turn requires compliance with the current manufacturer's Service Manual.

The landing gear rigging procedure as described in the Cessna 340 Service Manual is a lengthy process, extending to 10 pages of detailed instructions and including 76 individual tasks that must be performed. The Service Manual also requires that: 'Anytime a landing gear retraction or extension system component has been removed, replaced or the tension on the downlocks adjusted, the entire landing gear system must be re-rigged.'

The rigging procedure includes instructions for adjusting the side brace downlock links by means of a 'free-fall' downlock check. This requires that, when released from a position of between five and six inches inboard from the down and locked position, the landing gear must fall freely and lock down. The downlock link screws must then be wound out in half turn increments until the gear will no longer lock down following free fall, after which the adjusting screw is wound in:

'in small increments until the gear will free fall down and locked.'

The downlock link screw must then be safety wired in this position.

Following adjustment of the downlock links, the landing gear must be driven into the down and locked position, and the force required to break the downlock links out of their over-centre position must be measured, at right angles to the downlock link, using a force gauge. The allowable range of this breakout force is between 40 and 50 lbf.

The aircraft's maintenance records were reviewed. They showed that during the annual maintenance inspection, two worn bushes were replaced in the lower lugs of the right main landing gear bellcrank, which is a task requiring disassembly of the downlock link from the bellcrank. The forces required to break the downlock links out of their over-centre positions when the gear was down were recorded as 40 lbf for the right main gear and 50 lbf for the left main gear, both of which are within the Service Manual limits. The forces were measured using an electronic force gauge that had a NIST¹-traceable calibration certificate dated 1 March, 2011.

The landing gear maintenance tasks were performed by an unlicensed technician, Tech A, with assistance from a licensed engineer, Eng A. They were certified by a third person who held an FAA Inspection Authorisation. Tech A had conducted the majority of the landing gear

Footnote

¹ National Institute of Standards and Technology, USA.

maintenance, but was assisted by Eng A for certain tasks, including measurement of the downlock link over-centre breakout tensions. Tech A described in detail the individual tasks performed on the landing gear. These included jacking the aircraft, actuating the landing gear up and down using the electrical system, testing the gear up audible warning system and extending the landing gear using the emergency manual hand-crank. The rigging of the landing gear doors was checked, components lubricated and the worn bushes in the right bellcrank were replaced. The final maintenance action on the landing gear had been to extend the landing gear using the electrical system, before measuring the downlock link over-centre breakout tensions on the main landing gear, in addition to an equivalent check on the nose landing gear.

Whilst each of these individual tasks were described by Tech A as having been performed in accordance with the Service Manual, the entire 76-step landing gear rigging procedure had not been complied with, including the 'free-fall' downlock link adjustment procedure.

Metallurgical analysis

Avisual metallurgical analysis of the fractured downlock link adjusting screw and bellcrank pivot bolt was performed by an independent metallurgist (Figure 4), in addition to hardness testing of the adjusting screw material.

The metallurgist concluded that the downlock link adjusting screw had failed in a single, non-reversed, bending overload event. The fracture surfaces did not show any macroscopic evidence of pre-existing cracks, material defects or anomalies associated with crack initiation, and there was no evidence of slow crack growth mechanisms such as fatigue or stress corrosion cracking. The adjusting screw's material was found to



Figure 4

Fracture surfaces of the bellcrank pivot bolt and downlock link adjusting screw

be within specification for composition and mechanical properties.

The bellcrank pivot bolt was determined to have failed in single shear, resulting from a single overload event, and the fracture surface did not show any evidence of pre-existing cracking or material defects.

Analysis

Failure mode of the landing gear

Based on the observed damage to the right main landing gear components, it is probable that the downlock link or side brace, or both, were not sufficiently geometrically over-centre at the point the aircraft landed. In this condition, any inboard side-load generated by the right landing gear would cause the side brace to begin to fold, leading to the observed bending overload failure of the downlock link adjusting screw. Further rotation of the right landing gear leg would have then loaded the push-pull tube in tension, resulting in the tensile failure of the pivot bolt lug and single shear overload of the pivot bolt.

Cause of the landing gear collapse

The investigation was unable to resolve the conflicting evidence that, despite the landing gear being reported as having locked in the DOWN position, with three green DOWN position indicator lights visible to the pilot, the right main landing gear collapsed during a normal landing. Despite the omission of the 'free-fall' downlock link adjustment task during the landing gear maintenance activity, when tested, the over-centre breakout tensions on both main landing gear downlock links were within Service Manual limits. Therefore the omission of this maintenance task was not considered to be causal to the consequent landing gear collapse.

Deformation of the mounting bracket of the positionsensing microswitch on the right main landing gear, and fracture of the right downlock link adjusting screw, prevented subsequent functional testing of the landing gear system in the same condition that it had been in prior to the accident. Consequently the cause of the landing gear collapse was not positively identified.