Cessna U206A Super Skywagon, G-BGWR

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Aircraft Type and Registration:	Cessna U206A Super Skywagon, G-BGWR
No & Type of Engines:	1 Continental IO-520-A piston engine
Year of Manufacture:	1966
Date & Time (UTC):	7 October 2000 at 1230 hrs
Location:	Whitchurch (Tilstock) Airfield, Shropshire
Type of Flight:	Parachute dropping
Persons on Board:	Crew - 1 - Passengers - None
Injuries:	Crew - None - Passengers - N/A
Nature of Damage:	Nose landing gear, propeller, engine shock loaded
Commander's Licence:	Basic Commercial Pilot's Licence
Commander's Age:	34 years
Commander's Flying Experience:	470 hours (of which 191 were on type) Last 90 days - 104 hours Last 28 days - 24 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and metallurgical examination of failed bolt at DERA

History of the flight

The aircraft was returning to Tilstock at the end of a parachute dropping flight and, with all of the checks complete, was established on the approach to Runway 33R (Concrete 600 x 30 meters). Following an uneventful touchdown, the pilot closed the throttle to idle and then commenced to retract the flaps and apply simultaneous wheel braking. Initially the pilot felt that the brake pedals felt unusually 'stiff' and then the nose of the aircraft began to dip. At first he thought that the nose was just settling to the normal ground position but it then continued to sink. He immediately thought of shutting down the engine but before he could act the propeller blades had contacted the runway surface. The nose of the aircraft settled onto the nose wheel jamming it, and the aircraft skidded to a halt to the right of the runway centreline. The pilot vacated through the normal door uninjured.

The aircraft is equipped with fixed tricycle landing gear and on examination it was discovered that the $^{3}/_{16}$ inch diameter bolt (Part No NAS 464 P5 A42) securing the nose landing gear drag brace to the fuselage had failed (Figure 1). The bolt is used to secure the drag brace end fitting in a fuselage mounted fork fitting, consequently the design loading of the bolt is in double shear. The position of the failure through the bolt shank had occurred in the plane of the drag brace to fork fitting interface, towards the threaded end of the bolt. This had allowed the nose landing gear leg to pivot forward about its upper attachments.

Examination of failed bolt

The failed bolt was forwarded to the AAIB for metallurgical examination. A visual examination of the fracture (Figure 2) showed that failure had been preceded by growth of fatigue cracks through the majority of the shank section. One crack had grown through over half of the diameter from three origins on one side of the bolt (arrowed) and consisted of an initial corroded region (A) and a brighter, uncorroded region (B) in which coarse growth marks were visible. The corrosion had destroyed any growth marks over the initial part of the crack but it appears that there was a steady increase in crack growth rate as the crack grew. The size of this crack is consistent with failure under plain bending conditions.

Approximately 0.5 mm axially from the major crack a second crack had grown on the same side of the shank. A third, much smaller crack had developed on the opposite side of the shank. This crack also exhibited an initial corroded region and a bright region but, in this case, the latter region appears to have grown much more rapidly. This characteristic suggests that the corroded region had grown at a much earlier stage and that the bolt may have been previously removed and then refitted in a rotated position or had rotated in the assembly. Regions (C) and (D) both represent periods of accelerated growth before the final, ductile rupture. The small size of the ductile rupture zone indicates that the loads on the bolt were, generally, relatively low.

The shank of the bolt showed evidence of corrosion pitting over most of the available length. There were also signs of light wear, with a small step at the position of the other brace/fork fitting interface.

Hardness tests conducted on the bolt showed that the tensile strength was (c 1145 MPa, 166 ksi) within the specification for the material.

Previous cases

The aircraft manufacturer was aware of previous instances involving failure of the same bolt used to attach the nose landing gear drag brace to the fuselage fitting on Cessna 206 and 207 aircraft. They believe that past occurrences have been due to fatigue failures caused by bending in the bolt shank. They are of the opinion that the bending results from high side loads on the nose gear induced by towing or hard landings.

The manufacturer confirmed that there is no special inspection required of the bolt and that no life limit exists for the bolt.

Discussion

The nose landing gear drag brace to fuselage attachment bolt is by design loaded in double shear. However, the failure leading to this event and others known to the manufacturer occurred by a

fatigue mechanism resulting from plain bending. The bending loads could be generated by clearance gaps between the drag brace end fitting and the fork fitting, exacerbated by wear or high load events as proposed by the manufacturer.

The examination of the fracture indicated a relatively low operating load, given the small area of ductile rupture and the long term presence of cracks, indicated by areas of corrosion. It is also possible that the bolt had been removed and replaced when already cracked.

Given the low cost associated with the replacement of the bolt, compared with the resultant damage associated with bolt failure and the potential for occupant injuries, it would seem prudent to introduce an inspection or lifing policy for the bolt.

Conclusions

Failure of the nose landing gear drag brace to fuselage fitting bolt resulted from the growth of fatigue cracks through more than 90% of the shank cross section under the influence of plain bending loads. The condition of the bolt shank suggested that the fatigue cracks probably initiated at corrosion pits. A small region of crack growth may have occurred during an earlier period, before the bolt was removed and refitted. The strength of the steel from which the bolt was manufactured was within specified limits.

Safety recommendations

Recommendation 2000-65

It is recommended that the Federal Aviation Administration and The Cessna Aircraft Company consider implementing an inspection or lifing policy for the nose landing gear drag brace to fuselage fitting bolt (Part No NAS 464 P5 A42) on Cessna 206 and 207 aircraft.