Cessna 441 Conquest, G-FCAL

AAIB Bulletin No: 3/2002	**Ref: EW/G2001/04/15**	**Category: 1.2**
Aircraft Type and Registration:	Cessna 441 Conquest, G-FCAL	
No & Type of Engines:	2 Garrett Airesearch TPE 331-8-403S turboprop engines	
Year of Manufacture:	1982	
Date & Time (UTC):	21 April 2001 at 1217 hrs	
Location	Teesside International Airport, County Durham	
Type of Flight:	Aerial Work	
Persons on Board:	Crew - 3	Passengers - None
Injuries:	Crew -None	Passengers - None
Nature of Damage:	Damage to nose landing gear, forward fuselage, both engines and propellers	
Commander's Licence:	Airline Transport Pilots Licence	
Commander's Age:	42 years	
Commander's Flying Experience:	3,870 hours (of which 280 were on type) Last 90 days 103 hrs Last 28 days 38 hrs	
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB	

The commander reported that after take-off from Sumburgh Airport, the landing gear did not appear to retract correctly. It was noted that the landing gear 'Unlocked' light and the hydraulic pressure 'On' light both remained illuminated, indicating an abnormal condition. The landing gear was recycled with no resultant change to the indications. The landing gear was then selected down. Three green landing gear 'Down and Locked' lights illuminated and the abnormal indications disappeared.

The commander elected to carry out a flypast of the Control Tower at Sumburgh for a visual inspection of the landing gear. From this, ground observers reported that the nose landing gear did not appear to be extended correctly.

The commander then decided to reposition the aircraft to its base at Teesside Airport with the landing gear extended, where a further visual inspection confirmed that the nose landing gear was not locked down. The emergency blow-down system was operated, but had no effect. Fuel was then burnt down to a minimum quantity prior to landing, in accordance with the aircraft's checklist for unsafe nose landing gear indication.

After touchdown, the nose landing gear collapsed at approximately 70 kt and the aircraft came to a halt resting on its nose with consequent damage to both propellers, engines and the forward fuselage.

Subsequent examination of the nose landing gear system revealed that the bolt connecting the leg assembly to the drag brace link was missing (Figure 1 *jpg - 55kb*). It was concluded that the location of the downlock switch on the actuator body ensured that a 'gear safe' indication was provided in the cockpit once the gear was re-selected down. This occurred even though the nose leg was no longer geometrically constrained by the drag link and drag brace, once the bolt had been lost.

The loss of geometric locking had allowed the leg to pivot backwards during the landing. The evidence suggested that the piston rod of the hydraulic actuator unit had buckled under a high end load, applied as a result of the rearward displacement of this geometrically unrestrained leg. The leg was prevented from further backward travel by contact with the forward end of the drag brace, having displaced the latter and transmitted a load to the actuator.

Under normal ground loading, the geometrically locked drag brace and drag brace link combination carries all of the rearward load on the nose leg. The hydraulic actuator ensures that the geometric lock does not pass over-centre and 'break' the lock condition. With the drag brace link disconnected from the leg and the partly collapsed leg supported by the forward end of the drag brace, the large upward force on the end of the latter can only be reacted by the actuator. The resulting actuator force far exceeds that experienced in normal service, leading to compressive instability of the piston rod.

The head of the missing bolt was recovered from a location on the airfield at Sumburgh, which suggested that it had probably failed earlier and then fell out after the previous landing, during the evening before the accident. The remainder of the bolt, to which the nut was attached and split-pinned, was recovered from a position which suggested that it had fallen out during taxiing just prior to take-off on the accident flight.

A laboratory examination of the failed bolt was carried out. The bolt was found to have fractured perpendicular to its longitudinal axis, approximately half way along the shank, i.e coincident with the centre of the drag link. Fatigue cracking was evident, which appeared to have initiated from a single point and extended until the remaining bolt cross section was insufficient to carry the applied load. No evidence of any defect at the origin point was found.

The operator's fleet included a second Cessna 441, which performed a similar role and was of generally similar age and pattern of use to G-FCAL. The corresponding bolt was removed from the other aircraft and it was put through a magnetic flaw detection process. No evidence of cracking

was present. A further similar, but unused, bolt was removed from stock and the heads of all three bolts were subjected to hardness testing, since the material specification was not known. All three hardness values were in the range 397 to 409 HV10. It was noted that neither of the used bolts had been plated and both showed evidence of surface corrosion in the central shank area.

The drag brace link is fitted between two lugs, which form a fork as part of the nose leg. Any clearance between the lugs and the sides of the link would result in a bending moment in the bolt when fore and aft loads are applied to the leg. This would be at a maximum in the plane where this failure occurred.

It was concluded that loads due to landing, or those applied during towing operations, resulted in various magnitudes of bending moments being applied to the bolt, which in turn created fatigue stresses. Although no evidence of a specific defect could be seen at the origin of the fatigue crack, it is considered likely that a corrosion pit formed such an origin and thus initiated the fatigue process.