Enstrom F-28A, G-BWOV

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Incident

Aircraft Type and Registration:	Enstrom F-28A, G-BWOV
No & Type of Engines:	1 Lycoming HIO-360-C1A piston engine
Year of Manufacture:	1974
Date & Time (UTC):	4 November 2000 at 1230 hrs
Location:	Waterlooville, Hampshire
Type of Flight:	Private
Persons on Board:	Crew - 1 - Passengers - None
Injuries:	Crew - None - Passengers - N/A
Nature of Damage:	Major mechanical failure of engine
Commander's Licence:	Private Pilot's Licence
Commander's Age:	44 years
Commander's Flying Experience:	301 hours (of which 163 were on type) Last 90 days - 14 hours Last 28 days - 2 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and strip examination of engine by AAIB.

History of the flight

The helicopter was being used for a private flight between Bishops Waltham and Goodwood. The pilot owner had run the engine for about 10 minutes before taking off. About 5 minutes later, as the helicopter was approaching Waterlooville, the pilot initiated a gentle climb; all engine indications appeared normal at this stage. At about this time the pilot felt a small vibration in the cyclic control which caused him to check the instruments and trim. Almost immediately there was a loud 'bang', the cabin began to fill with smoke and the helicopter yawed to the right. The pilot immediately lowered the collective lever to enter an autorotative descent and turned, almost directly into wind, away from the built up area ahead. He then transmitted a 'Mayday' call, selected a large field and carried out a successful 'run-on' forced landing. The pilot then shut the helicopter down before getting out. With the assistance of a witness who had approached to see if help was required, the pilot inspected the engine and found that it had suffered a catastrophic failure. In response to the Mayday, the police and fire service arrived very soon after the accident.

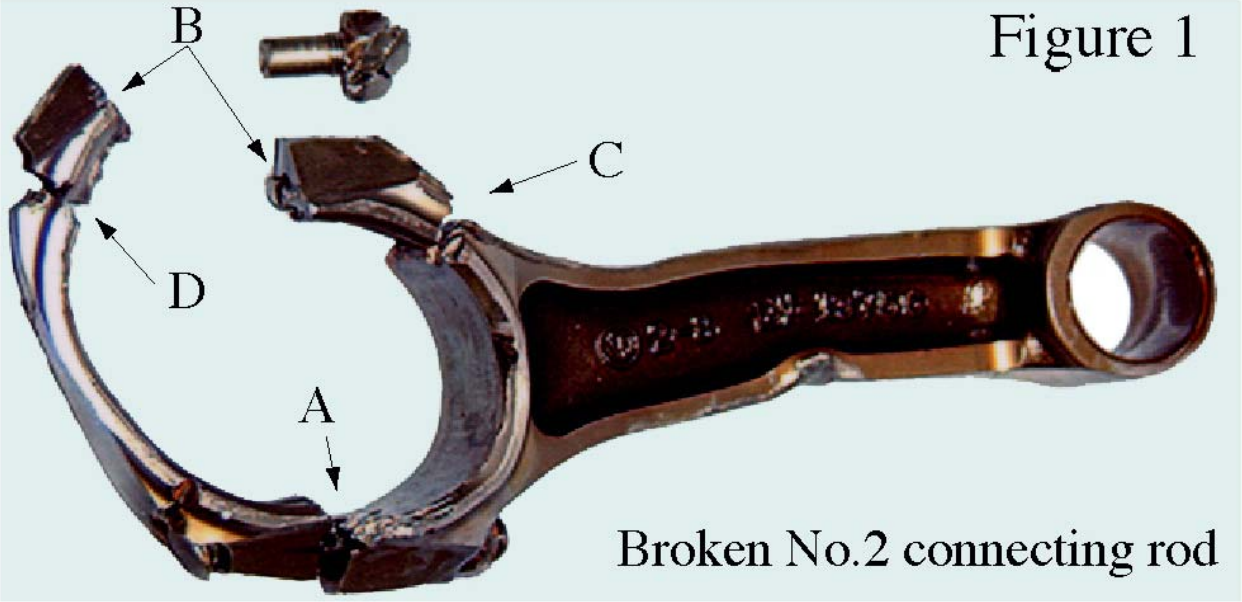
Examination of the engine

After the aircraft had been recovered to a repair agency, the engine was removed and taken to the AAIB facility at Farnborough for examination together with fragments of the engine found, immediately after the forced landing, on the 'tray' below the engine. Examination revealed that the big end of the No.2 connecting rod had failed and had broken out of the top of the crankcase. After dismantling the engine, it was established that there was no evidence of any damage preceding the big-end failure. All crankshaft journals, including the No 2 crankpin, had retained their surface finish, indicating that no loss of lubrication had occurred.

Examination of the No 2 connecting rod big end (see illustration) revealed that both cap bolts had failed close to the mating faces and that both the rod (at C) and the cap (at D) had broken through their sections on the same side of the bearing. Both halves of the cap bolt from the unbroken side of the rod (A) were recovered, but only the bolt tail and nut from the other side (B) were found.

Metallurgical examination of the No 2 big end components revealed the presence of high cycle fatigue in the failure across the section of the cap at 'D'. As a result of subsequent damage to the failure surfaces in the area where the fatigue had originated, it was not possible to establish whether or not there had been any significant pre-existing damage or defects in the area of the fatigue origin.

The failures across the section of the rod at 'C', and that of the bolt 'B', were both the result of high strain, low cycle, fatigue. The failure of the bolt at 'A' was the result of bending overload. The observed failures were consistent with the primary failure having been a tensile fatigue failure of the cap. As a result of this cap failure, the remainder of the cap attached by the bolt at 'B' had acted as a 'hook' and had applied large cyclic bending loads to the connecting rod at 'C' and large cyclic tensile loads to the bolt at 'B', inducing consequential failure of both.



Service history

The engine had been imported from the USA in November 1988, installed in a different helicopter, at which time it had run for 1550 hours total and 490 since overhaul. It was removed from this helicopter in May 1989, having not run since being imported and fitted to another Enstrom F28A, G-BAWI. It remained in this helicopter until June 1992, at which time G-BAWI was involved in an accident resulting from a loss of engine power which had occurred during a 'towering' take off. At this time the engine had run a total of 2165 hrs since new, and 1107 hrs since overhaul.

The engine then entered a period of non-use, at the end of which it was overhauled and subsequently fitted to G-BWOV in November 1996. From that time until December 1998 it had accumulated a further 350 hrs, at which time it suffered a reported engine overspeed incident of greater than 10%, and was consequently subjected to a full overspeed inspection. This included the dismantling, inspection and reassembly of the engine using new big end bolts and new bearing shells. It was subsequently refitted to G-BWOV which was, at that time, in use as a training helicopter.

G-BWOV was subsequently sold to the current owner who had been operating it for about 12 hours. The engine failed in flight some 128 hrs after the last reported overspeed.

Subsequent action

The failure of a connecting rod big end cap was extremely unusual. The failed parts were sent to the manufacturer, together with the known engine service history. During their inspection, the manufacturer detected evidence of 'galling' on the big-end cap in the vicinity of the fatigue failure. Galling in bearing housings is normally associated with movement of the bearing shells within the housing and is known to generate surface defects which can be conducive to fatigue initiation. It does not occur under normal operating conditions, but is a common result of engine overspeeding. The overhauliers who performed the last overspeed check were fully aware that galling of big-end housings was unacceptable and that connecting rod assemblies with galling damage must be scrapped.

Discussion

The investigation found the presence of galling damage to the failed big-end cap which was consistent with the type of damage most frequently associated with engine overspeeding. This finding suggested that this engine, after it had been subjected to the previous full overspeed check inspection and rectification, may have suffered at least one unreported overspeed event which had caused the galling found present on the big end cap. This galling could have initiated the fatigue failure of the cap.

This incident highlighted the importance of having a full overspeed inspection performed following engine overspeeds of more than 10%.