SERIOUS INCIDENT

Aircraft Type and Registration:	DHC-1 Chipmunk 22, G-BXHA	
No & Type of Engines:	1 De Havilland Gipsy Major 10 Mk 2 piston engine	
Year of Manufacture:	1952 (Serial no: C1/0801)	
Date & Time (UTC):	22 March 2022 at 1410 hrs	
Location:	Sevenoaks, Kent	
Type of Flight:	Training	
Persons on Board:	Crew - 2	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Cracked propeller and boss blocks	
Commander's Licence:	Airline Transport Pilot's Licence	
Commander's Age:	38 years	
Commander's Flying Experience:	9,000 hours (of which 5 were on type) Last 90 days - 70 hours Last 28 days - 16 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot and additional enquiries by AAIB	

Synopsis

During the flight the aircraft developed severe vibration requiring the pilot to return to the airfield where fatigue cracks were found in the propeller and its two mounting blocks. The cracks originated from fretting between the propeller assembly and splines on the engine hub.

The aircraft's Type Responsibility Agreement holder, CAA and LAA are taking combined safety action to promulgate enhanced guidance for continued airworthiness of Fairey Reed propellers. This action is in addition to existing inspection and maintenance requirements to owners of aircraft using this propeller type.

History of the flight

During the initial climb after takeoff, the pilot noticed some subtle airframe vibration. However, due to a lack of recency on type, he could not recollect if the level of vibration was normal for the aircraft and elected to continue the flight.

While manoeuvring, the airframe vibrations increased abruptly and to a level that the pilot had difficulty reading the instruments. The pilot returned to the airfield where during the taxi the vibration caused the low voltage warning light to fall out of the instrument panel.

Aircraft information

General

The de Havilland Canada DHC-1 Chipmunk is a low-wing, single engine aircraft. G-BXHA was manufactured in the UK in 1952 and was equipped with a Gipsy Major 10 Mk 2 piston engine, fitted with a Fairey Reed A66753/X1 fixed-pitch aluminium propeller. This propeller type is fitted on numerous piston engine aircraft operating with either a CAA Certificate of Airworthiness, CAA Permit to Fly or a LAA administered Permit to Fly. There is no Formal Design Authority for Fairey Reed propellers; however, the aircraft's Type Responsibility Agreement holder holds the technical dataset.

Propeller assembly

The propeller is paired with forward and aft boss blocks made from cast aluminium (Figure 1).

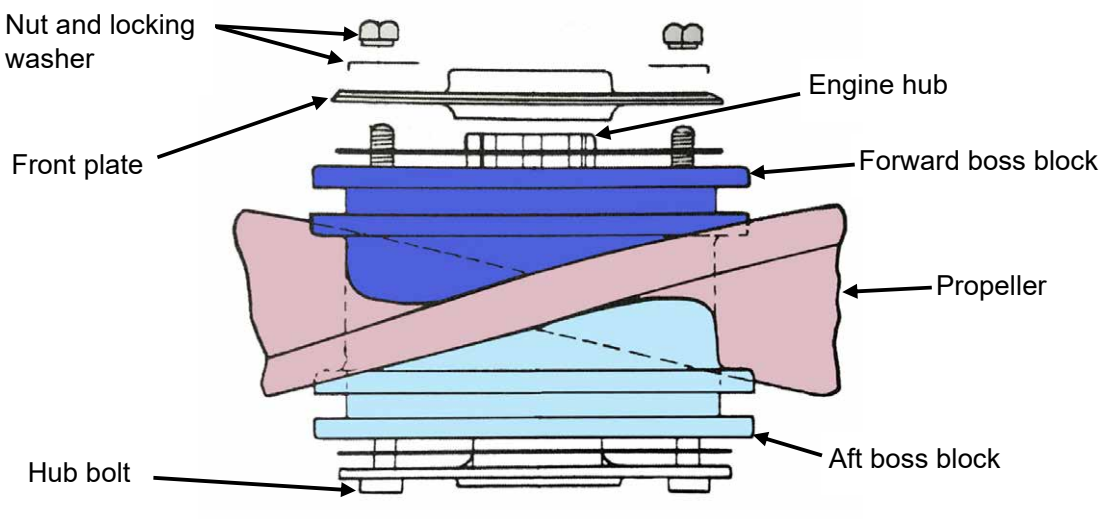

Figure 1
Propeller assembly arrangement

The boss blocks each have one flat surface and one curved surface that is matched to the contour of the propeller face. The propeller assembly's integrity relies upon a close fit between the blocks and propeller surfaces. The assembly is installed on a splined engine hub and held in place by eight propeller hub bolts and nuts.

Aircraft maintenance history

In November 2000, the aircraft's propeller and boss blocks were removed and replaced with an overhauled propeller assembly. An invoice showed that in April 2015 the propeller assembly was removed and subjected to an eddy current inspection; however, there was no record in the aircraft logbook to explain why this was carried out. There is also no evidence that the propeller assembly had been subject to damage or repair.

In April 2017, the propeller assembly was removed and Service Bulletin (SB) FRP.001.[1] was carried out. This SB requires a visual inspection for cracks of the propeller and boss blocks; if there is any doubt as to the condition of the propeller, the SB recommends that a dye penetrant technique should be used. However, the SB does not specify the inspection of the inner diameter of the boss blocks for wear or corrosion. The dye penetrant inspection was not carried out and there is no record of any damage having been found on the propeller assembly.

At the time of this event, the propeller had flown 97 hours since the SB was last carried out.

Examination of propeller assembly

General

Two cracks were found in the propeller, four cracks in the forward boss block and three in the aft boss block (Figure 2).

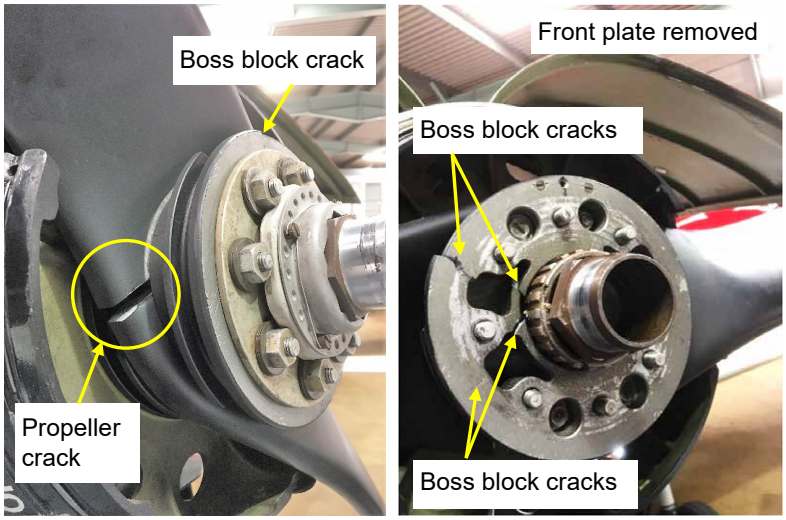

Figure 2

Propeller assembly with spinner removed showing cracks in forward boss block and propeller

Alignment of propeller assembly

The propeller and boss blocks are considered as one unit, and the boss blocks are not interchangeable between other propellers. SB FRP.001.1 states that before dismantling, a white alignment mark should be painted down one side of the boss blocks. No such mark was present on the propeller or boss blocks to verify their correct alignment during the last reassembly. Following this event, the fit of the blocks to the propeller was found to be satisfactory and the serial numbers for the three propeller assembly components were correct.

Footnote

[1] SB FRP.001.1 requires the servicing and inspection of all Fairey Reed fixed pitch metal propellers and boss blocks at 300 hour intervals.

Propeller

The propeller had a crack that extended through a hub bolt hole, completely through the material's thickness. A second crack was evident at a second propeller hub bolt hole (Figure 3).

The surface finish of the bolt hole radii[2] and propeller face were not *'smooth and highly polished'* as specified in the Fairey Reed Repair Specification[3].

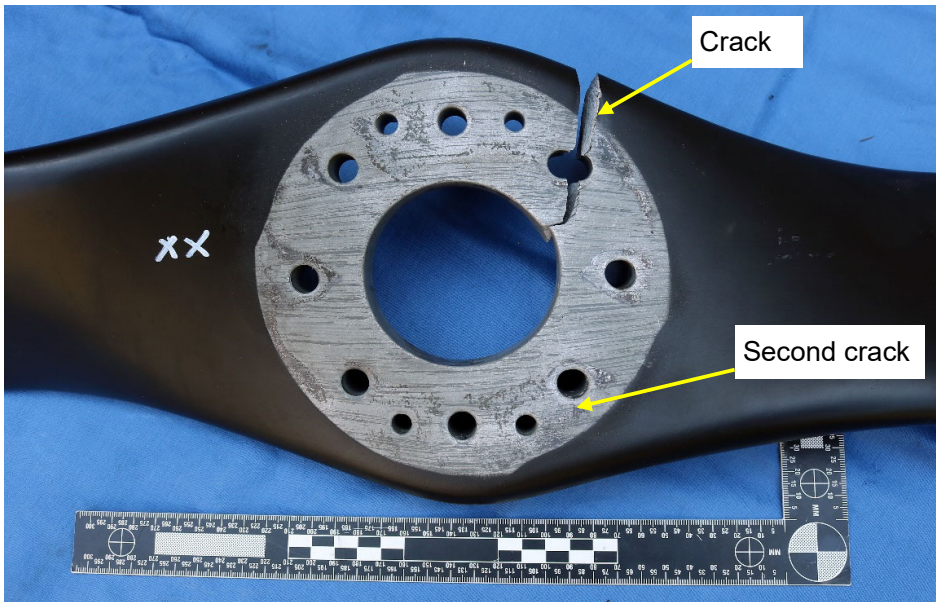

Figure 3

Cracks in propeller

Splined engine hub

There was evidence of fretting and corrosion on the splines of the engine hub with corresponding marks on the inner surfaces of the boss blocks and the propeller (Figure 4). Some marking of the forward boss block inner diameter is considered typical for the propeller's age and type.

One of the propeller mounting bolts was bent. Torque values of the propeller mounting nuts were assessed by the maintenance organisation to be normal.

Footnote

[2] The outer edge of a hole, typically rounded off where it meets the material's upper and lower surfaces.
[3] Repair of Fairey Metal Propellers General Specification F.A.C.1, (Issue 3, April 1950)

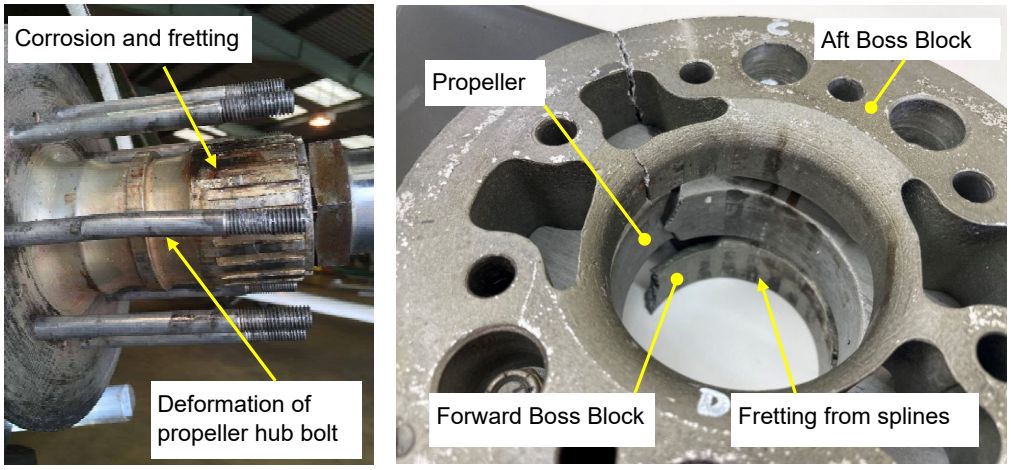

Figure 4

Engine hub corrosion and fretting, and fretting of inner surfaces of blocks and propeller

Analysis of fracture surfaces

The propeller and boss blocks were examined by a metallurgist.

Failure of boss blocks

Of the four cracks in the forward boss block, one was assessed as the primary fatigue fracture and the remaining three were assessed as secondary overload failures. The primary fracture originated from a worn area on the inner diameter, caused by fretting from the splines of the removable propeller hub. Thumbnail shaped deposits of oxide and rust at the edge of the fracture surface (Figure 5) indicated that the crack initially grew slowly and then accelerated when it was a few millimetres deep. The crack had grown to approximately 20 mm in length when final failure occurred.

The aft boss block had fractured in three places, resulting from overload failure.

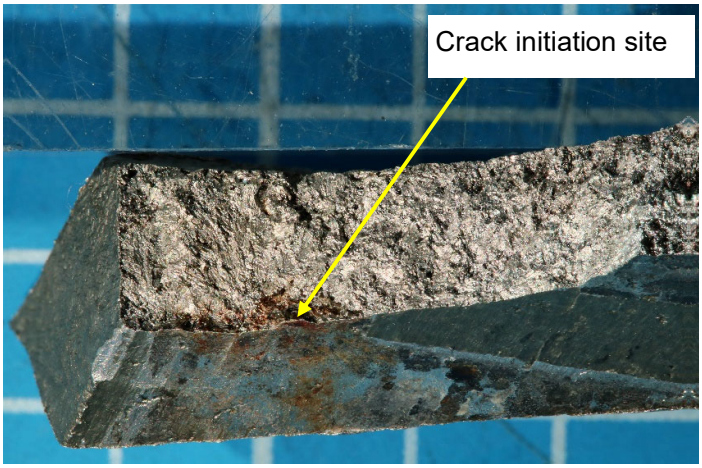

Figure 5

Primary fracture surface of forward boss block

Failure of the propeller

The primary fatigue crack of the propeller initiated on opposite sides of a propeller hub bolt hole (Figure 6). There is no evidence of damage associated with crack initiation on one side of the hole. On the other side of the hole, the crack initiated from a small gouge; however, this damage was not considered to be large enough to have initiated the fatigue failure.

The secondary fatigue crack in the propeller also initiated from the radius of a bolt hole; there was no evidence of pre-existing damage around this hole.

The surface finish of the radii on the bolt holes and the propeller face were not in accordance with the manufacturer's specification. However, this was not considered to be the primary origin of the fatigue failures in these areas.

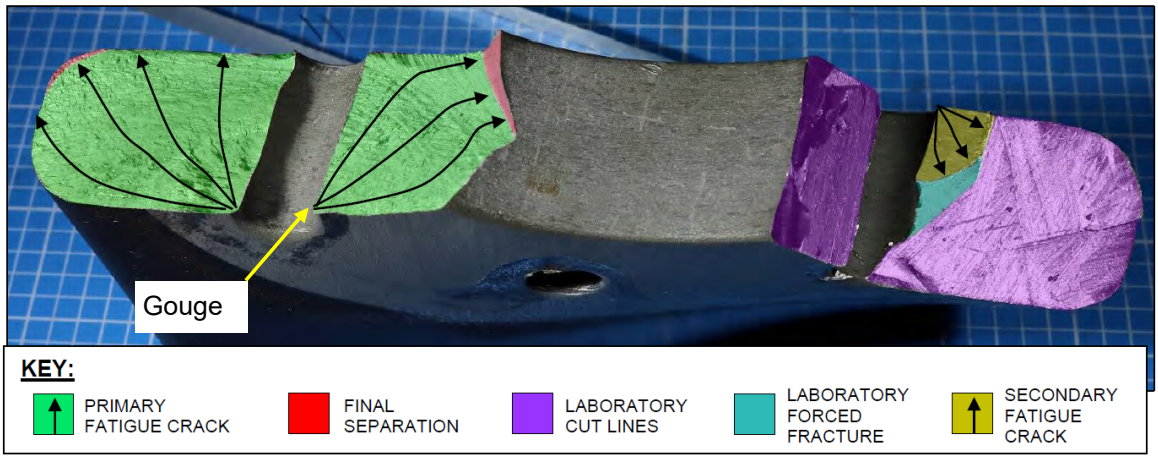

Figure 6

Propeller fracture surfaces

Sequence of failure

The fretting and cracking on the forward boss block and propeller developed at the same time, probably as a result of abnormal loading on the propeller assembly. It was not possible to determine how long the primary crack on the propeller had been present, nor was it possible to identify a source of the abnormal loading.

It is assessed that when the primary crack in the forward boss block reached approximately 20 mm in length, the propeller's primary crack separated. This was followed by separation of the forward boss block primary crack and finally both boss blocks in overload.

Conclusion

The initiating failure of the propeller assembly was caused by fatigue cracking of the forward boss block and propeller, resulting from fretting and corrosion. The existing SB to inspect the propeller assembly does not specify inspection of the inner diameter of the boss blocks for wear or corrosion.

As a result of this investigation, the aircraft Type Responsibility Agreement holder, the CAA and LAA are taking the following Safety Action:

Aircraft Type Responsibility Agreement holder

Will promulgate a Technical News Sheet to its subscribers which will include enhanced guidance for continued airworthiness of Fairey Reed propellers. This will include the use of Non-Destructive Testing, and inspections for corrosion, fretting and correct surface finish.

CAA and LAA

Will work together to promulgate the content of the Technical News Sheet to owners of this propeller type operating under a UK CAA Certificate of Airworthiness, UK CAA Permit to Fly, or LAA administered Permit to Fly.