



# Engineering examination Cracked McCauley propeller hub

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## Abstract

A McCauley Propeller Systems propeller hub with an area of transverse cracking extending through the hub mounting boss was received by the Australian Transport Safety Bureau (ATSB) from the Civil Aviation Safety Authority (CASA). CASA requested assistance from the ATSB to conduct an engineering examination of the cracked region.

The examination determined that the crack was the product of a high-cycle, low-stress fatigue mechanism, with the crack origin centred on a mounting stud hole. There were no associated defects or other anomalous features that may have assisted in the crack initiation.

## FACTUAL INFORMATION

A McCauley Propeller Systems propeller hub, originating from a Cessna Aircraft Co. model U206G aircraft, was received by the Australian Transport Safety Bureau (ATSB) from the Civil Aviation Safety Authority (CASA), with a request for an engineering examination of cracking within the lower body of the hub. The propeller was a model D3A34C404-C constant-speed unit; serial number 930046.

## Propeller hub examination

The propeller hub presented with a crack visible to the naked eye on the exterior of the hub. The crack was approximately 50mm in length and was oriented circumferentially around, and parallel to, the propeller mounting boss (Figure 1). One of the threaded hub mounting studs adjacent to the crack had been removed prior to the ATSB's examination. Minor abrasion was observed

adjacent to one end of the crack, with no evidence of other defects or anomalies. Fluorescent penetrant inspection indicated that the crack was also open to the interior wall of the hub (Figure 2).

The hub was sectioned to excise the portion containing the crack. A laboratory fracture was then performed to expose the crack faces (Figure 3). The crack surface presented as a faceted, quasi-cleavage fracture, radiating outward from the threaded mounting stud hole.

Optical microscopy revealed step-like indications, consistent with a progressive crack growth (fatigue) mechanism. The marks were concentric and radiated away from the mounting stud hole origin (Figure 4).

**Figure 1: Propeller hub**

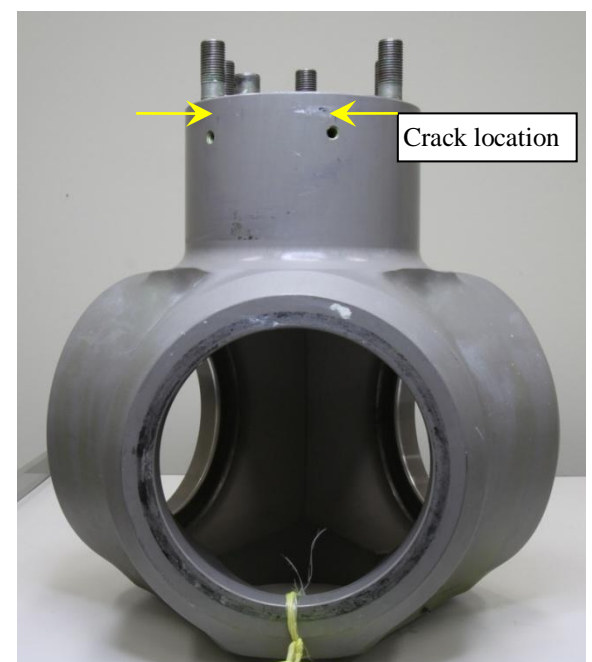


Figure 2: Fluorescent penetrant inspection with crack indications on the hub exterior (top) and interior (bottom)

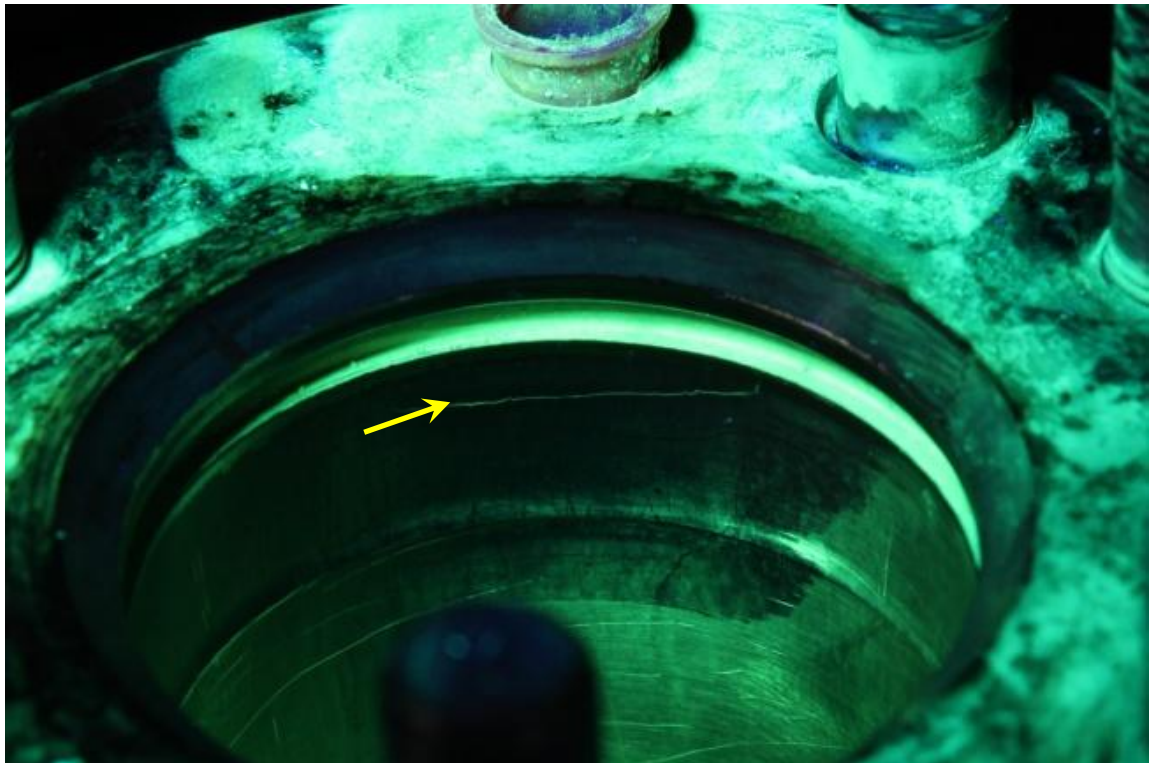


Figure 3: Crack surface after laboratory fracture

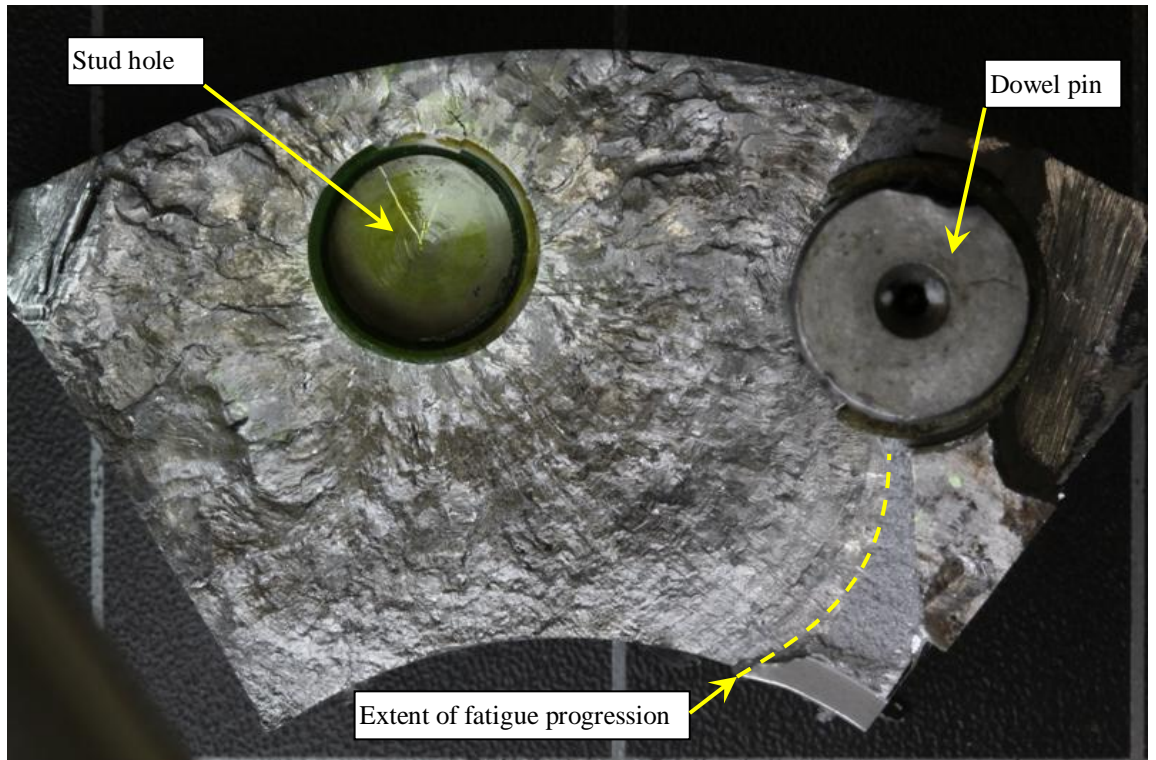
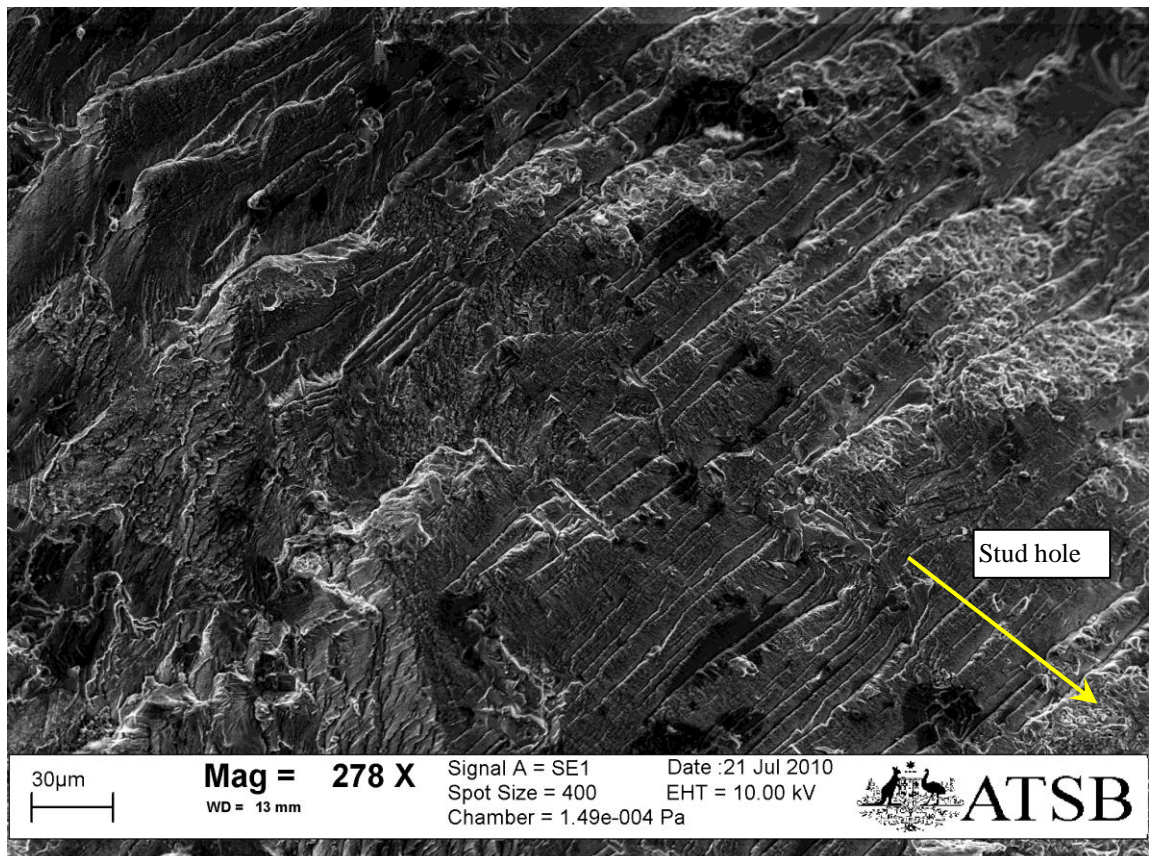


Figure 4: Step-like crack progression marks



A section through the stud hole threads showed the thread-form to be in good general condition, with no significant defects (Figure 5).

Energy Dispersive Spectroscopy (EDS) of the hub material confirmed its production from an aluminium alloy, with key additions of copper, manganese, magnesium and silicon. The chemistry was consistent with the nominal composition of a 2xxx series aluminium alloy. A metallographically-prepared cross-section, taken through the stud hole, presented an elongated grain structure, interspersed with two characteristic precipitates - most likely aluminides ( $\text{CuAl}_2$ , light-etching, and  $(\text{FeMn})_3\text{SiAl}_{12}$ , dark-etching). The microstructure was typical of this type of alloy in the wrought condition (Figure 6). No unusual microstructural constituents, physical defects or other anomalous metallurgical features were observed.

## ANALYSIS

The fracture surface morphology and presence of crack progression marks was consistent with the initiation and propagation of a high-cycle, low-stress fatigue cracking mechanism from the internal bore of a single mounting stud hole within the propeller hub boss.

While there was no direct evidence of the factors that had contributed to crack initiation from this area, the absence of any product deficiencies, such as gross material defects or pre-existing thread-form damage (stress concentrators), suggested that crack formation may have been related to installation of the hub mounting stud, and/or the level of tension maintained within the stud during its operational life.

Figure 5: Section through stud hole threads

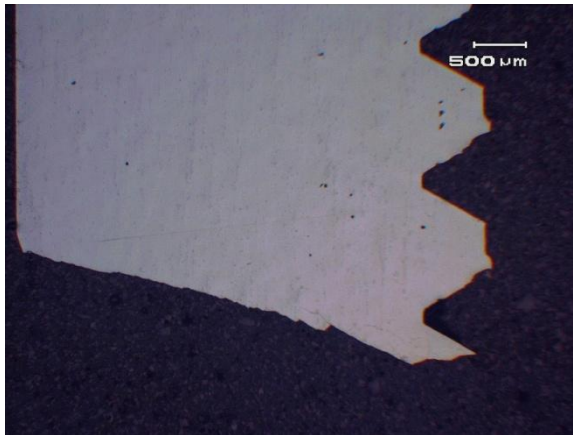


Figure 6: Alloy microstructure

