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Fatigue analysis of a P180 aircraft main landing gear wheel flange

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Abstract

A piece of inner wheel flange separated from the main landing gear (MLG) right wheel of a Piaggio Avant P180 aircraft during taxing on the runway. The wheel was a 2014-T6 aluminium alloy and had been in service 22 years. Morphological observation of the fractured surfaces indicated fatigue was the cause of failure. The crack grew to approximately 8 cm in length and 5 cm in deep before the final catastrophic failure and was due to a corrosion pitting promoted by fretting from the tyre bead and the tube well, thus causing the removal of the protective coating. The fatigue life assessment also provided an estimation of the number of flight cycles to failure supported by the wheel during the crack propagation confirming those accumulated since its last inspection. It was recommended the inspection interval be reduced one-third of its original one as well as a proper maintenance procedure to be introduced in order to verify the integrity of the coating, to remove eventually corrosion and re-protect the component.

Keywords: Aluminium alloy; Fatigue failure; Flange; Landing gear; Wheels

1. Introduction

The Piaggio Avant P180 aircraft had landed and as taxing on the runway when a loud bang coming from the right side of the aircraft was heard from the crew. An initial visual examination showed approximately half of the inner wheel flange fillet was separated from the landing gear wheel. In Fig. 1 is given a schematic view of the aircraft MLG wheel, whereas Fig. 2 shows the view of the fractured wheel as received. In particular, A represents the piece of wheel flange fillet fractured and separated from the wheel assembly and B the remember of the wheel, respectively. The failed wheel was forged from 2014-T6 and had been in service for 22 years since its manufacture. The component had been inspected non destructively by means eddy current 4 years before the catastrophic failure, in accordance with the manufacturer's manual. Such manual concerns also hardness measurements at the thermo plugs to verify any sort of overheating. No indication of defects as well as overheating were found. At the moment of the accident the wheel had also carried out 1200 flight cycles since last

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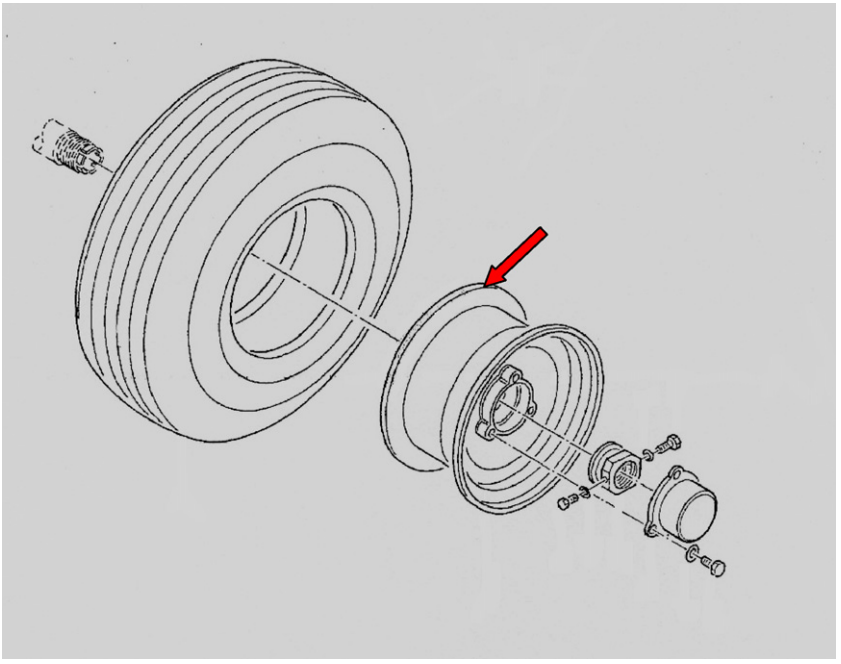

Fig. 1. Schematic view of the P-180 aircraft MLG wheel. An arrow marks the inner flange.

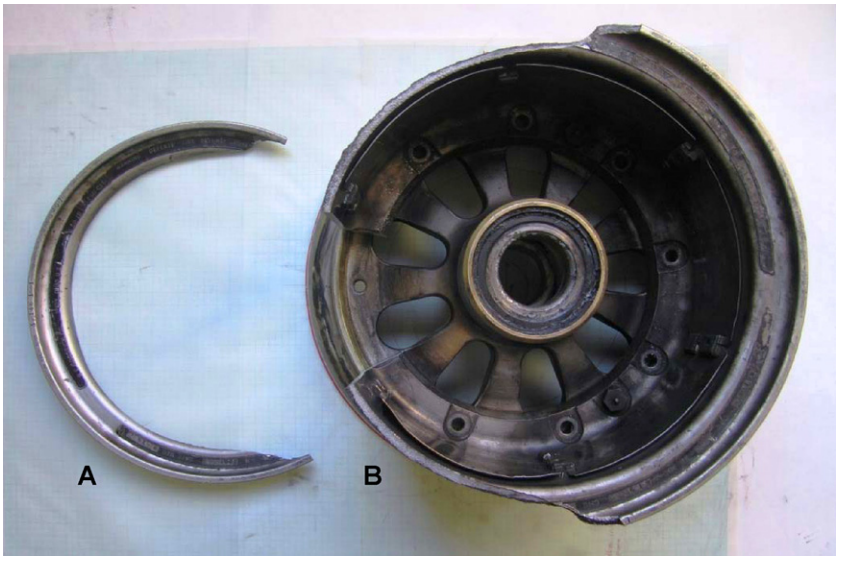

Fig. 2. General view of the failed wheel.

inspection, 300 cycles less than its limit scheduled at 1500 cycles. The experimental procedure used to identify the cause of the failure included visual, i.e. eye and optical microscope, and fractographic, i.e. field emission scanning electron microscope (FESEM) examinations, material characterisation (namely chemical analysis, hardness measurements and metallography) and X-ray energy dispersive spectroscopy (EDS).

The results indicated the crack growth in the flange fillet was caused by fatigue. Such crack grew to approximately 8 cm in length and 5 cm in deep before the final catastrophic fracture. Multiple initiation sites due to corrosion pits existed and the largest one was measured to be approximately 315 μm deep. In particular, the