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Case study

Metallurgical failure analysis of a cracked aluminum 7075 wing internal angle

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ABSTRACT

Internal angles are used to strengthen Aircrafts center box corners where the wing is attached to the airframe. There are 16 angles in Airbus A300s wing box. On the right side, rear spur, and lower flange area of the center wing box, one of these angles had been cracked with a length of 28 mm. This crack has decreased residual strength of the part under allowed values and resulted to a rupture in the rear spur lower cap. Several reports of the same occurrences in other Airbus A300 air crafts, highlight the importance of finding the causes of this failure. Detailed optical and SEM, plus 4 other metallurgical tests were conducted on the failed angle. Finally, it was concluded that corrosion fatigue was the main reason which itself comes from manufacturing, maintenance, metallurgical, and geometric reasons as were discussed in this study.

1. Introduction

An internal angle fitting related to center box of Airbus A-300 submitted for failure investigation, which is shown in Fig. 1.

This component was a structural component of a 14-year-old commercial jetliner that had carried out approximately 19,000 flight cycles when the crack was detected through NDT implementation. This type of aircraft is mostly utilized by cargo airlines. The aircraft had been grounded for service, and specific NDT operation had been implemented according to manufacturer service bulletin which notifies all operators of A-300 to conduct this test for those aircrafts that their flight cycles exceeds 17,000 cycles [1]. NDT detected a crack between two fastener holes in a way that affect residual strength of the part. Airbus had issued a service bulletin to replace this component with a modified substitute. The location of the component in the airframe is illustrated in Fig. 2.

As an independent failure investigation, metallurgical properties of the angle had been studied with tests, corresponding scientific data had been gathered, and failure causes had been clarified.

2. Chemical quantitative test

With the aim of understanding chemistry of the component, quantitative test was conducted on it. Achieved information about composition of elements that are mentioned in Table 1 had been compared to similar Alloys. It had been concluded that this chemistry is similar to aluminum 7075.

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Fig. 1. Image of cracked internal angel after removing from A/C.

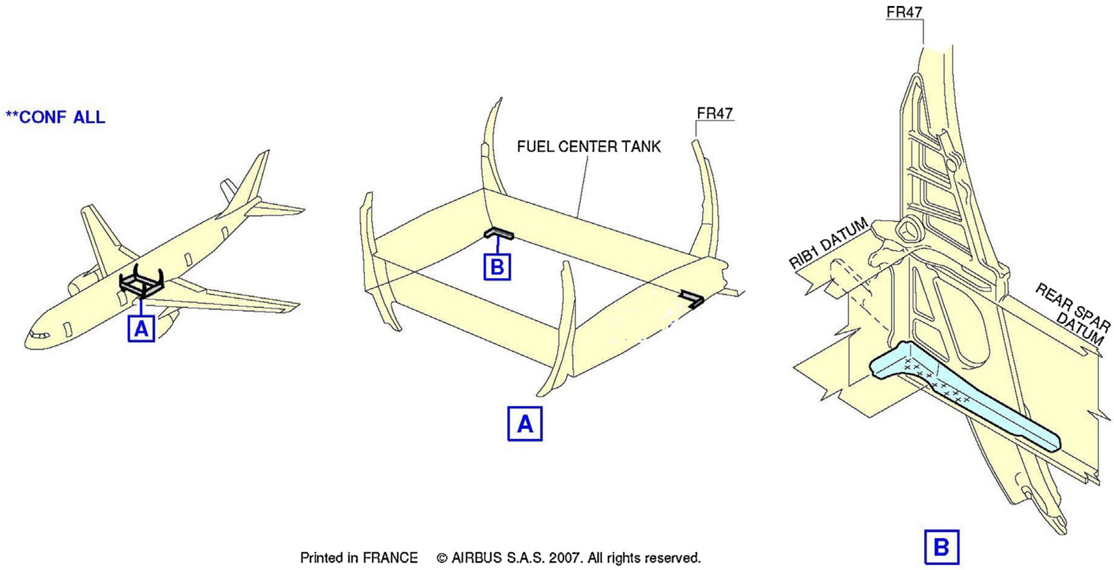

Fig. 2. Illustration of internal angles location [1].

Table 1
Chemical composition of the angle gained by quantitative test.

Si%	Fe%	Cu%	Mn%	Mg%	Cr%	Ni%	Zn%	Ti%	Pb%	V%	B%	Al%
0.06	0.18	1.45	0.01	2.57	0.18	0.011	5.70	0.007	0.004	0.008	0.003	Base

3. Tensile test

Table 2 shows tensile test results for all three specimens. According to very results, material of the component is isotopic. There was not found any kind of coating on the surface of the part.

4. Hardness test

Surface hardness of the component was taken and the results are illustrated in Table 3. As it is shown, there is not any remarkable change in hardness all over the part.

5. Qualitative assessment of loading and stress distribution

Precise analysis of loads was requiring a complete CAD model of the structure. Providing this model was not possible at this study. Therefore, it is attempted to provide a similar configuration of corresponding structure in order to simulate effect of Wing loading on stress distribution of the angle. Although the realistic magnitude of stresses over the angle would not