Airframe In-Service Pitting Corrosion

Subjects: Engineering, Aerospace

Contributor: Loris Molent

Pitting corrosion is a major maintenance problem for aircraft aluminium alloys, and is also a problem for other materials. It has been considered that some service examples of corrosion-induced pitting or cracks exposed to service environments. These examples support the contention that fatigue crack growth, which is mainly due to in-flight dynamic loads, is not significantly influenced by the environment, unlike the largely static exposure on the ground.

Keywords: aircraft ; AA7050 ; pitting corrosion ; corrosion-assisted fatigue ; variable amplitude fatigue

1. Overview[1]

Airframe corrosion maintenance and control are major sustainment cost drivers and availability degraders. This is despite good design; corrosion prevention and control plans; and the use of various protection systems, including anodising layers on aluminium, cadmium and chromium plating of steels, special coatings such as ion vapour deposition (IVD) aluminium, corrosion-inhibiting paint primers and topcoats. The protection systems degrade in service, and corrosion commences. This has the potential to impact aircraft structural integrity if not adequately addressed.

2. Management of Airframe In-Service Pitting Corrosion by Decoupling Fatigue and Environment

Management of aircraft fatigue and environmental degradation is generally well understood when these aspects are viewed as distinct and separate tasks in typical Aircraft Structural Integrity Management Plans (ASIMP). For example, this is the case for fatigue nucleating from unintentional manufacturing discontinuities, often surface connected, that occur in typical production-quality metallic airframes; and also for assessing the effect of corrosion (material loss) on static strength and stiffness and hence the structural integrity.

On the other hand, when there are corrosion-related fatigue problems, notably the nucleation and growth of fatigue cracks from corrosion damage, the only currently available remedy is ‘find and fix’, i.e., when corrosion is found, it has to be removed and the affected area restored to full structural integrity. This situation exists mainly because: (i) The onset of degradation or damage of the metal’s protective surface treatment is not predictable; (ii) Concerns that fatigue cracking (should it exist) will be influenced by the presence of a corrosive environment, as it is well known that cracking in corrosive environments occurs at significantly higher rates than in laboratory air (i.e., the source of most fatigue crack growth rate data); (iii) The transition of corrosion is not well understood; and (iv) Approved analytical tools are not available to determine the significance of corrosion, when detected, for the fatigue of aircraft structures.

3. Conclusion

Here, it provides examples of fatigue cracking and growth from service-induced corrosion pits, followed by a discussion of managing corrosion pitting in a framework that differs from the ‘find and fix’ method. The purpose of this discussion is to continue support, based on fracture mechanics, such that detected corrosion is left in service for a short well-defined period, for example until the next maintenance. This approach avoids unplanned maintenance, which is very expensive owing to logistical problems, e.g., personnel availability and aircraft operational requirements. If the removal of corrosion pitting until the next planned maintenance is possible, then this by itself should save much unnecessary expense while allowing for the continuance of operational capabilities.

References

1. Molent, L. and Wanhill RJH; Management of Airframe In-Service Pitting Corrosion by Decoupling Fatigue and Environment. *Corros. Mater. Degrad* **2021**, *2*, 493–511, .