# 등가초기균열(EIFS)를 적용한 장기운영 항공기 구조물의 수명평가

## An evaluation of fatigue life for aging aircraft structure using equivalent initial flaw size (EIFS)

**Abstract**

Aging aircraft structures are inevitably exposed to environment for a long time facing many potential problems of corrosion and wide spread fatigue damage, which in turn cause the degradation of flight safety. In this study, the environmental surface damages on aging aircraft structures induced during service were quantitatively analyzed. Also, the S-N fatigue tests were performed with center hole specimens extracted from aging aircraft structures. From the results of quantitative analysis for the surface damages and fatigue test, it is concluded that corrosion pits initiated during service reduces the fatigue life significantly. Finally, using the fracture mechanics and EIFS (equivalent initial flaw size) concepts, the remaining fatigue life was predicted based on actual fatigue test results.

***Keywords: aging aircraft, EIFS, F-5 structural part, S-N fatigue, corrosion damage***

### 1. Introduction

Aging aircraft structures are inevitably exposed to environment for a long time facing many potential problems of corrosion and wide spread fatigue damage, which in turn cause the degradation of flight safety [1-2]. In this study, effect of environmental damages in real aging aircraft on remaining fatigue life has been examined.

### 2. Experimental procedure

#### 2.1. Visual inspection on environmental damages in aging aircraft

To identify the environmental damages in aging aircraft, visual documentation was conducted using digital camera, optical microscope and scanning electron microscope (SEM).

#### 2.2. S-N fatigue test

Center hole and hour-glass type specimens were prepared from aging F-5E aircraft and uniaxial S-N fatigue tests were conducted in laboratory air at an R ratio of 0.1 and sinusoidal frequency of 40 Hz in accordance with ASTM E466 using a servo-hydraulic testing machine.

#### 2.3. Fractographic analysis and fracture mechanics modeling

The SEM fractographic and micrographic analyses were conducted on fatigue tested

specimens. To predict S-N fatigue life of the as-cut specimens from aging aircraft, fracture mechanics modeling based on EIFS (equivalent initial flaw size) was utilized. For simplicity and practicality, environmental damage was assumed as a semi-elliptical surface crack in sheet.

## 3. Conclusions

In the present study, both test and prediction were conducted to identify the remaining fatigue life of aging F-5E aircraft and the following conclusions were drawn.

1. Various types of environmental damages were observed on aging F-5E structural parts.
2. Fatigue tests on the specimens prepared from the F-5E 15% spar showed a significant reduction in fatigue life, as shown in Figure 1, with surface corrosion damage.
3. Environmental damages could be quantified by SEM fractographic analysis as EIFS values for fatigue life prediction based on LEFM.
4. Remaining fatigue life of structural parts from aging aircraft could be successfully predicted by LEFM modeling based on EIFS concept, as demonstrated in Figure 2-3.

## 4. Reference

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[2] J.J. Medved, M. Breton and P.E. Irving: *Int. J. .Fatigue*, 2004, vol. 26, pp.71-80.

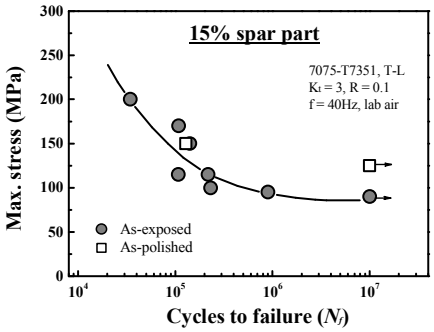


Figure 1. S-N fatigue curves for the specimens prepared from F-5E.

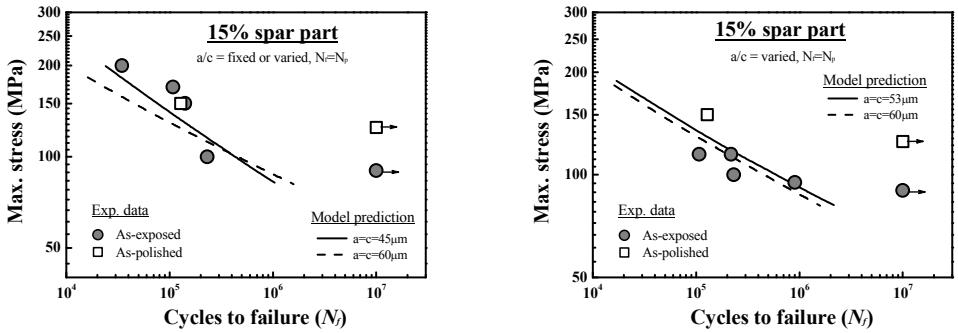


Figure 2. S-N fatigue life prediction on (a) elongated and (b) round types of crack initiation site quantified by SEM fractographic analysis as EIFS values.

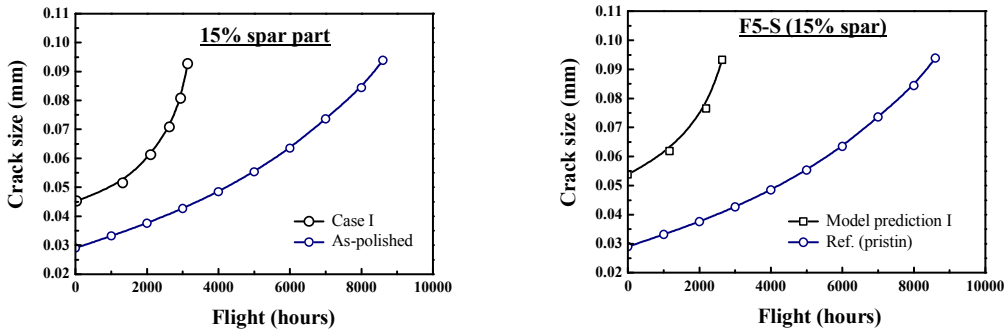


Figure 3. Remaining fatigue life curves on (a) elongated and (b) round types of crack initiation site using random load spectrum.