Determination of inspection interval for aircraft structures using Stochastic Approaches

SungJin Kim
Dept. of Aerospace and Mechanical Engineering, Korea Aerospace University
grease999@naver.com

Hee-Seong Kim
Dept. of Aerospace and Mechanical Engineering, Korea Aerospace University
heesung1206@naver.com

Joo-Ho Choi
School of Aerospace and Mechanical Engineering, Korea Aerospace University
jhchoi@kau.ac.kr

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Research Objective

Traditional method to determine inspection interval is deterministic which cannot consider the variability of the parameters in crack growth model.
To overcome this, the stochastic methods have been studied and developed in developed countries. The stochastic methods to determine inspection interval of the aircraft structure are examined and compared using same crack growth data.

Expected Contributions

- The required input data could be determined in order to apply the methods.
- When using SLAP method, the upper limit of the initial inspection time can be determined using safety criteria of RCMA method.

State of Research

In this study, one deterministic(ASIP) and two stochastic(RCMA, SLAP) methods were examined and implemented to the fighter bulkhead data. The computed Inspection intervals were compared in view of several aspects such as the safety criteria and characteristics for determining inspection interval.

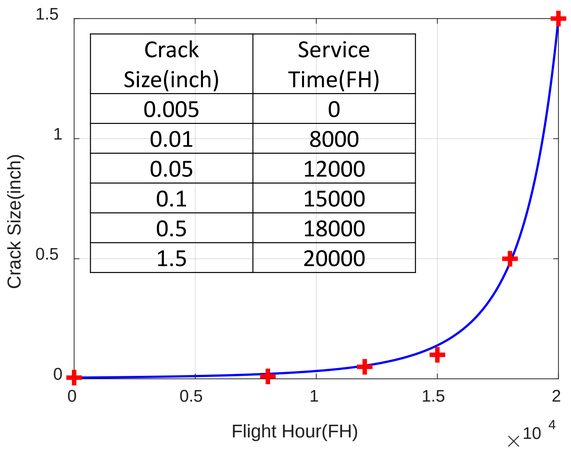
Next Steps

- The stochastic methods including RCMA and SLAP would be applied to other crack growth data.
- The methods to determine the repeat inspection interval considering the present risk rate per flight hour would be studied .
- The methods and assumptions would be compared and be verify using the simulation, test data and field data.

Research Details

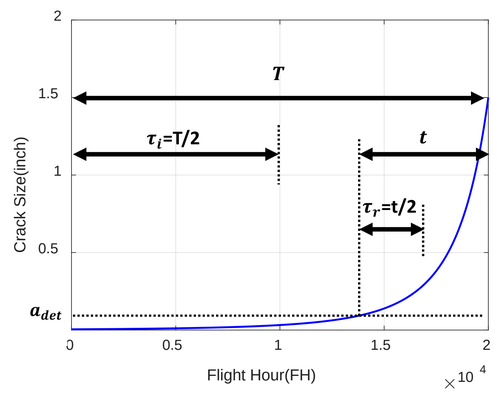
Fighter bulkhead Median Crack Growth data (Manning & Yang et al., 1992)

Crack Size(inch)	Service Time(FH)
0.005	0
0.01	8000
0.05	12000
0.1	15000
0.5	18000
1.5	20000



Critical crack size, a_{cr} : 1.5 in.
NDI Method : Eddy Current Method
Detectable crack size, a_{det} : 0.1 in.
Assumed Life time : 20000FH
Allowable Class A mishap risk rate per FH, R_a : 5e-8
Conditional probability of Class A mishap, P_a : 0.8
Life dispersion parameter, σ_z : 0.29
PDF of time to Critical crack size : $Lognormal(\ln 20000\,, \sigma_z^2)$

ASIP Method (MIL-STD-1530)



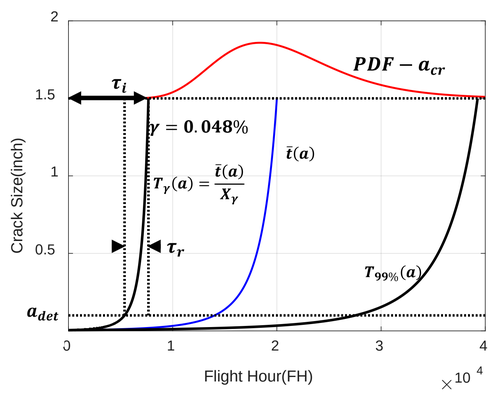
Criterion
Median Crack Growth Curve

Crack growth curve
$\frac{da}{dt} = Qa^b$

Initial inspection time, τ_i
10000FH

Repeat inspection interval, τ_r
2989FH

Reliability Centered Maintenance Analysis(RCMA) (Manning & Yang et al., 1992)



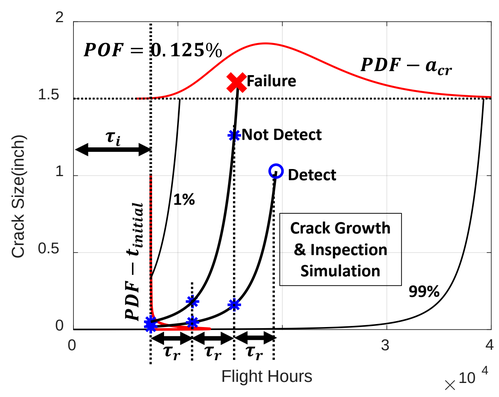
Criterion
$R_a = \frac{F_{\tau_i}(a>a_{cr})\times P_a}{\tau_i} = \frac{\gamma \times P_a}{T_\gamma(a_{cr})}$

Crack growth curve
$\frac{da}{dt} = XQa^b$
$\ln X \sim N(0, \sigma_z^2)$

Initial inspection time, τ_i
7675FH

Repeat inspection interval, τ_r
2593FH

Stochastic Life Approach(SLAP) (Grooteman, 2004)



Criterion
$R_a = \frac{POF \times P_a}{20000FH}$

Crack growth curve
$\frac{da}{dt} = Qa^b$
$\ln t(a_{cr}) \sim N(\ln \bar{t}(a_{cr}), \sigma_z^2)$

Initial inspection time, τ_i
7400FH

Repeat inspection interval, τ_r
4741FH

Conclusion

- The repeat inspection interval by SLAP method that uses inspection simulation considering the probability of detection is the largest.
- The initial inspection upper limit could be determined by considering safety criteria of RCMA method.

Acknowledgments and References

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