PEMODELAN DAN SIMULASI NUMERIK *FATIGUE CRACK GROWTH RATE* AKIBAT *CYCLIC LOADING* PADA STRUKTUR *DOUBLER FUSELAGE SKIN STATION NUMBER* 360–380 *STRINGER* 6L–7L PESAWAT BOEING 737-900 *EXTENDED RANGE*

Lado Rislya Prakasa
NIM: 17050125

ABSTRAK

Untuk mengetahui kekuatan struktur doubler dalam menahan terjadinya kegagalan akibat retakan yang disebabkan oleh cyclic loading, diperlukan suatu analisis tersendiri yang tidak terdapat pada panduan Structural Repair Manual (SRM). Cyclic loading dapat mengurangi kekuatan skin doubler secara bertahap (fatigue) hingga mencapai kegagalan (fracture). Pada penelitian ini akan dilakukan analisis crack growth rate dan jumlah siklus pembebanan yang dibutuhkan untuk memunculkan retakan dengan panjang tertentu (fatigue cycle) terhadap struktur doubler fuselage skin pesawat Boeing 737-900 Extended Range dengan station number 360-380 di antara stringer 6L-7L pada setiap panjang retakan dan ketinggian terbang simulasi.

Analisis dilakukan menggunakan pendekatan numerik dengan metode Modified Virtual Crack Closure Integral (MVCCI) untuk mendapatkan nilai Stress Intensity Factor (SIF) melalui software berbasis metode elemen hingga. Melalui nilai yang diperoleh dapat diketahui bahwa nilai crack growth rate dan fatigue cycle berbanding lurus terhadap variasi panjang retakan dan ketinggian terbang simulasi yang diberikan.

Nilai crack growth rate paling rendah terjadi pada struktur doubler dengan panjang retakan 8,5 mm dan kondisi terbang 5000 feet yaitu sebesar $2{,}964 \times 10^{-15}$ *mm/cycle, dan nilai tertinggi sebesar* $5{,}471 \times 10^{-12}$ *mm/cycle terjadi pada struktur doubler dengan panjang retakan 51 mm dan kondisi terbang 40000 feet. Sedangkan, nilai fatigue cycle paling rendah terjadi pada struktur doubler dengan panjang retakan 8,5 mm dan kondisi terbang 40000 feet yaitu sebesar* $2{,}540 \times 10^{13}$ *cycle, dan nilai tertinggi sebesar* $5{,}470 \times 10^{15}$ *cycle terjadi pada struktur doubler dengan panjang retakan 51 mm dan kondisi terbang 5000 feet.*

***Kata kunci**: Crack growth rate, Fatigue cycle, Modified Virtual Crack Closure Integral (MVCCI), Stress intensity factor, Struktur doubler*

NUMERICAL MODELING AND SIMULATION OF FATIGUE CRACK GROWTH RATE DUE TO CYCLIC LOADING ON DOUBLER STRUCTURE FUSELAGE SKIN STATION NUMBER 360-380 STRINGER 6L-7L BOEING 737-900 EXTENDED RANGE AIRCRAFT

Lado Rislya Prakasa
NIM: 17050125

ABSTRACT

In order to determine the strength of the doubler structure in resisting failure due to cracks caused by cyclic loading, a specific analysis excluded from Structural Repair Manual (SRM) is necessary. The cyclic loading can reduce the strength of the skin doubler in a gradual manner (i.e. fatigue) until reaching fracture. This research will analyze the crack growth rate and the number of loading cycles required to generate a crack with a certain length (i.e. fatigue cycle) in the doubler fuselage skin structure of the Boeing 737-900 Extended Range aircraft with a station number of 360-380 between 6L-7L stringers at certain crack lengths and simulated flight altitudes.

The analysis was carried out by using a numerical approach employing Modified Virtual Crack Closure Integral (MVCCI) method to obtain the Stress Intensity Factor (SIF) value through a finite-element based software. Through the values obtained, it can be seen that the value of the crack growth rate and fatigue cycle is directly proportional to the certain crack lengths and simulated flight altitudes.

The lowest crack growth rate was produced in the result of doubler structure with a crack length of 8,5 mm and a flight altitude of 5000 feet, which was 2,964 $\times 10^{-15}$ *mm/cycle, and the highest value of 5,471* $\times 10^{-12}$ *mm/cycle was found for doubler structure with a crack length of 51 mm and flight altitude of 40000 feet. Meanwhile, the lowest number of fatigue cycle value was obtained in the result of doubler structure with a crack length of 8,5 mm and a flight altitude of 40000 feet, which was 2,540* $\times 10^{13}$ *cycle, and the highest value (i.e. 5,470* $\times 10^{15}$ *cycle) was calculated in the case of doubler structure with a crack length of 51 mm and a flight altitude of 5000 feet.*

Keywords*: Crack growth rate, Doubler structure, Fatigue cycle, Modified Virtual Crack Closure Integral (MVCCI), Stress intensity factor*