STRESS ANALYSIS OF CN-235 FLAPTRACK

FOR FATIGUE LIFE DETERMINATION

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ABSTRACT

Flaptrack is a vital component connected to the wing box structure to allow the flap extension and retraction, in order to raise the lift by changing the curvature of airfoil section. The Aviation Regulation requires strength analysis proven by testing.

This paper describes stress analysis of the flaptrack using finite element method in order to support fatigue life determination. The analysis is compared with experimental result.

INTRODUCTION.

CN-235 is a multi purpose 44 seater commuter aircraft with twin turboprop Engine CT 7-9 developed by joint cooperation of IPTN/Indonesia and CASA/Spain. The airplane obtained FAA certificate in the late 1986.

One of the primary structure is the wing, on which the flap is attached for high lift devices. The mechanism to allow flap motion from 0° to 35° is the so called FLAPTRACK (Figure-1 and Figure-2). For the wing flap and its supporting structure, it must be shown by analysis and

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supported by test that no catastrophic failure should occur due to cyclic loading during its life time.

Structural geometry of the flaptrack can be divided into (Figure-3): rail where the flap carriage sliding on, left and right side walls, basis, ball screw actuator support and fittings of the track to the wing structure. The external loads come from flap surfaces through the front

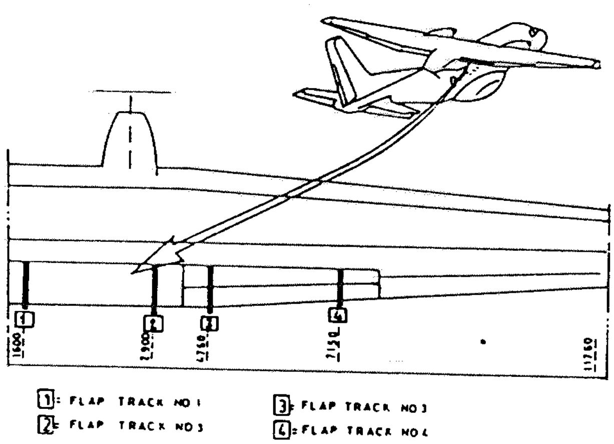


Figure-1 Flaptrack location in CN-235 Aircraft.

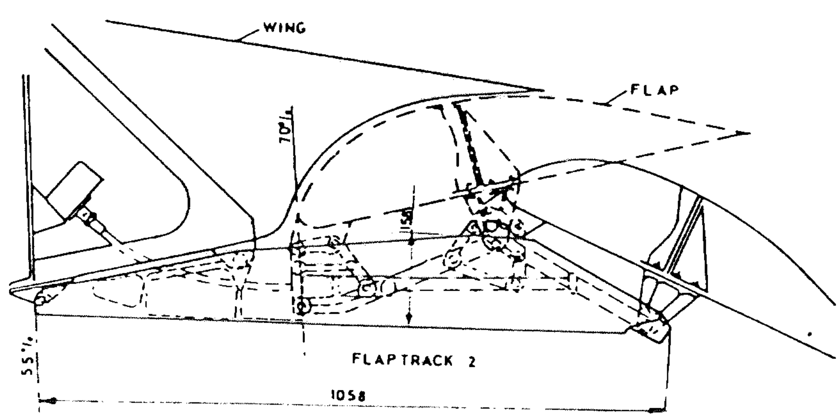
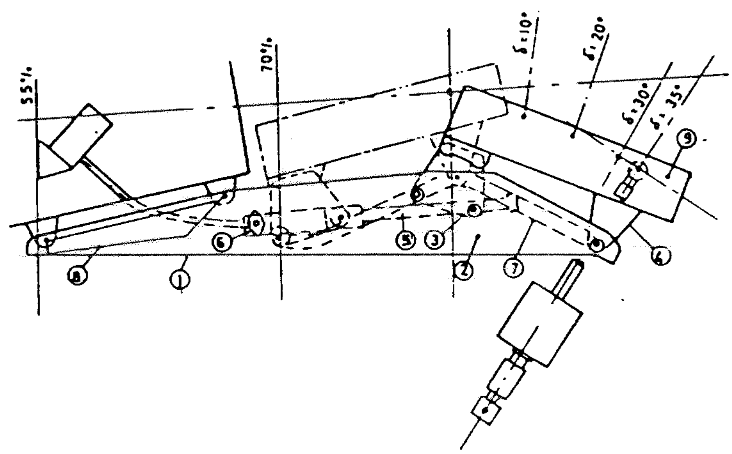


Figure-2 Wing-Flap-Flaptrack side view arrangement.

and the rear carriage to the rail of the track. The fittings at the wing box anticipate the loading. The basis reacted as tension due to bending moment.



1. Basis
2. Side
3. Forward Carriage
4. Rear Carriage
5. Ball Screw Actuator
6. Ball Screw Actuator Support
7. Rail
8. Flaptrack Support
9. Flap Dummy

Figure-3 Flaptrack main components.

FINITE ELEMENT MODEL

In the first part of analysis, several models were studied using combinations of CROD, CBAR, CTRIA3, CQUAD4, CPENTA, and CHEXA elements. Three Dimensional Model was used where the basis and the side wall were idealized as plate bending elements to allow the forces transmision from one side wall to another. Solid elements were used in the

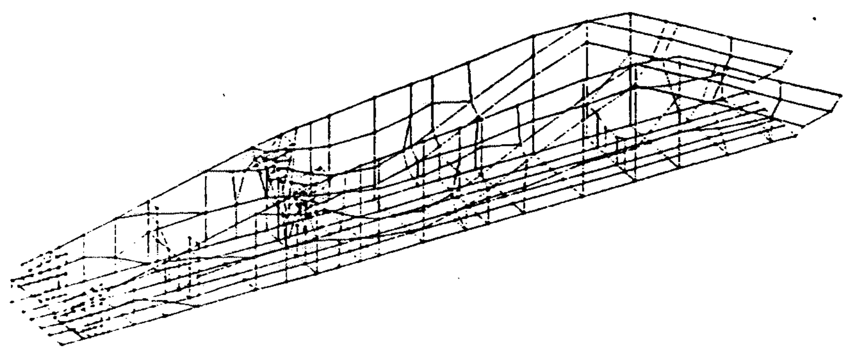


Figure-4 Finite Element Model.

fitting area (Figure-4). The types of element and its quantity are as follows:

GRID	382	CPENTA	14
CBAR	104	CHEXA	24
CTRIA3	42		
CQUAD4	241	Total element	425

The purpose of such a model is to obtain reasonable internal load distribution. The modelling was done using software CADAM V20.1.1 for pre-processor, and CAEDS output display version 1 for post-processor. The MSC/NASTRAN V64A run on IBM main frame 3090-200 installed at IPTN's Computer Center.

For fatigue and crack propagation analysis, further refinement is necessary because fatigue phenomena is associated with local stress distribution. Several critical areas with high far field stress and high stress concentration must be analysed using more number of element. Such analysis for instance, was carried out on the fitting connections (Figure-5). The result was then used to calculate fatigue life as well as crack propagation.

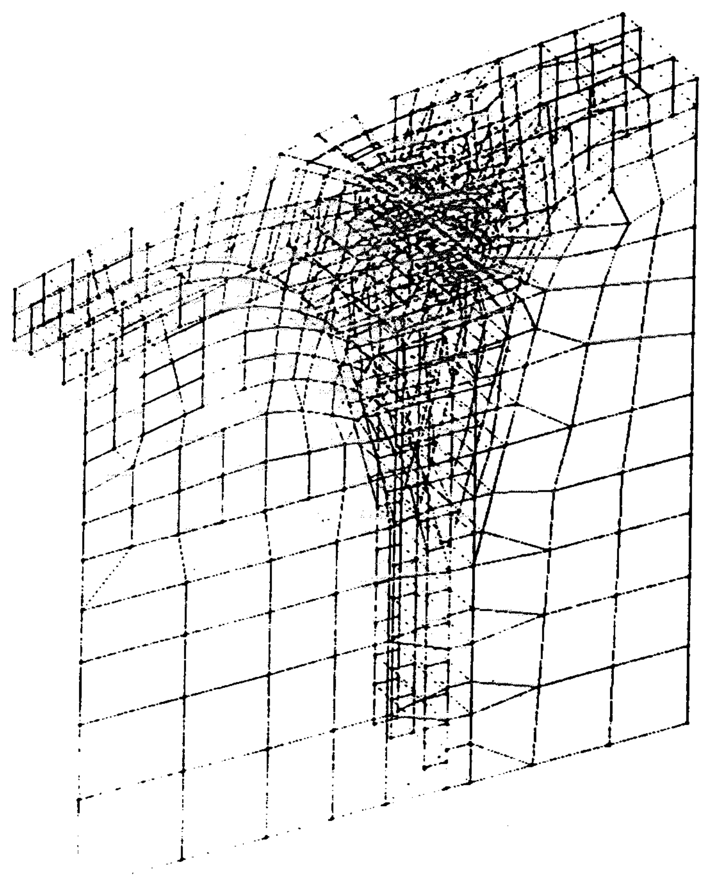


Figure-5 FEM in the vicinity of rear flaptrack support.

FATIGUE TEST

CN-235 flaptrack Fatigue Test is executed to demonstrate life guarantee of the structure during operation, to reveal critical areas, and to define inspection program based on damage tolerance concepts. The test is executed at The Material and Structure Laboratory in Serpong, 50 km south of Jakarta.

For calibration, strain measurements were carried out using 10 strain gauges, (Figure-6) and compared to finite element analysis. Afterward flight simulation test was executed using simplified operational load (Figure-7).

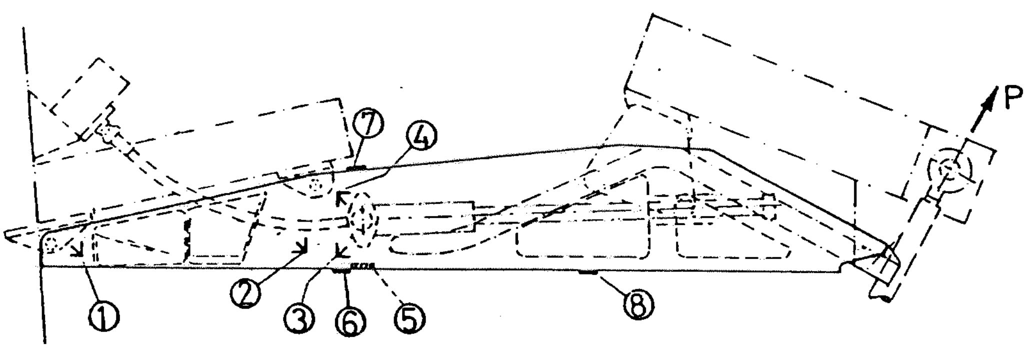


Figure-6 Strain gauges location.

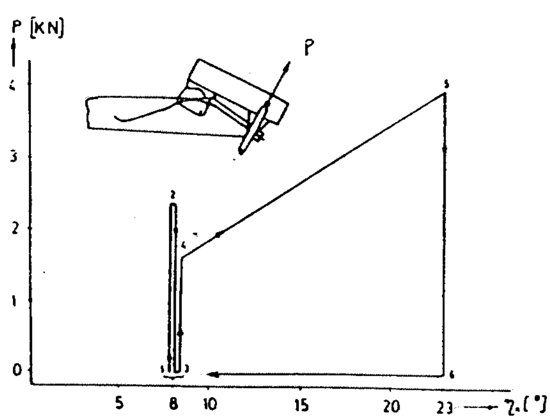


Figure-7 Operational load sequence for one flight.

As for now two lives (120,000 flights) have been simulated with no crack occured in the structure.

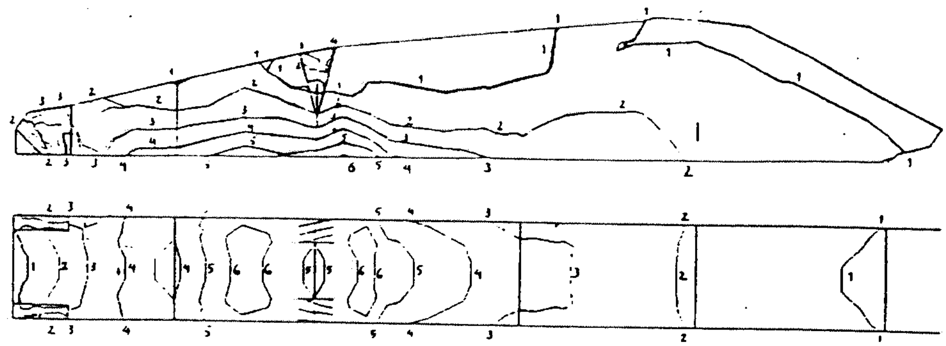
CLOSING REMARK

Figure-8 shows the stress distribution on the side wall and the basis of flaptrack. Based on this stress distribution, critical areas can be determined and are used to perform further stress analysis. Deformation of the structure under a typical load is shown in Figure-9. In general, comparison between finite element method analysis and test yield rather good result, see Table-1.

The modelling of pin in the hole of the side wall requires carefull attention since it is very essential to obtain accurate local stress distribution for fatigue life estimation. It is basically surface contact problem which generally require a vast number of elements.

Table-2 Comparison of Maximum Strain between Test and FEM Analysis.

SG	TEST		FEM	%
no.	$\mu\varepsilon$	θ	$\mu\varepsilon$	Difference
1	644	30	-	-
2	475	15	493	3.8
3L	524	13	561	7.1
3R	594	7	561	5.5
4	112	28	112	0.0
5L	522	0	725	38.9
5R	553	0	725	31.1
6	585	0	544	7.0
7	-363	0	-529	45.7
8	270	0	226	16.3



Isostress value :

1 = 0.3 daN/mm	4 = 2.4 daN/mm
2 = 1.0 daN/mm	5 = 3.1 daN/mm
3 = 1.7 daN/mm	6 = 3.8 daN/mm

Figure-8. Maximum Principal Stress Contour of Basis and the Side-wall.

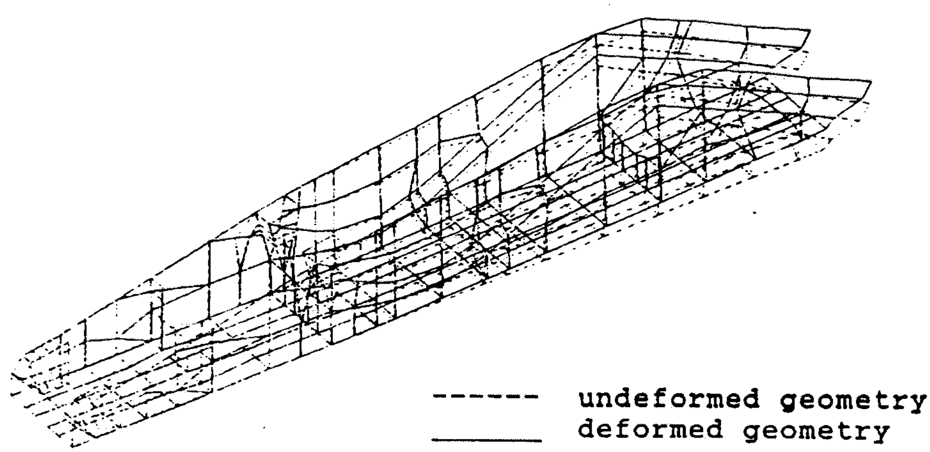


Figure-9 Geometrical displacement.

<u>REFFERENCE :</u>

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2. Pramono, Rudianto, Hein, "CN-235 Flaptrack Fatigue Test", TD 85-3241, IPTN, Bandung, 1985.

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