Journal of Data Acquisition and Processing
ISSN: 1004-9037
https://sjcjycl.cn/
DOI: 10.5281/zenodo.7765784

FABRICATION OF MOUNTING BRACKET USING GLASS FIBER AND EPOXY COMPOSITES

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Abstract—This paper reviews some of the advances that have been made in stress analyses of the mounting brackets of aircraft component. Finite Element Analysis is implemented to calculate stress-intensity factors precisely for finding pits instructures. Observations of small-crack behavior at open and rivet-loaded holes and the development of small-crack theory have leads to the prediction of stress-life performance for components with stress concentrations under aircraft spectrum loading. By using the technique called crack-closure concept crack growth can be easily monitored in the aircraft structures. These advances are helping to assure continued safety of aircraft structures the main motivation is that to increasing the life of the material used for mounting brackets for structural application. i.e. increases the No. of cycles to failure (Nf) of the material.
Key Words: Mounting Bracket, glass fibre, epoxy resin, rivet-loaded holes, crack growth, fatigue life.

1. INTRODUCTION

Fatigue was a major criterion in Aircrafts and other structural industry because of its nature to decrease the life span of components. [1].with the help of modern computer technologies we easily predicted the stress dominant factors on 3D cracks in a realistic manner. [2].

Therefore fabrication of fatigue and corrosion less structures is impossible nowadays even though with modern techniques. But the improvement in design, computational analysis increases the life span of the component. [3] This presentation is focused on such methods with special emphasis on practical fatigue reliability considerations.[4] All structures or components have traditionally been designed using time based structural and fatigue analysis methods. By fatigue analysis approach, optimized stress design be achieved in an effective manner.[5]Therefore with this technique we had many advantages like empathetic the fatigue nature and analysis the detailed 3D structures instead of simplified 2D structures. [6]

Basically composite be made up of, primary strengthen fibers and binding resin matrix with some additives. Wood and bone are natural composite materials: wood consists of cellulose fibers in aligning matrix and bone consists of hydroxyapatite particles in a collagen matrix. [7]Frequently used composites in aircraft industries are glass-fiber-reinforced plastic and sometimes with carbon for better strength which involve both carbon and glass fibres, both of which are stiff and strong (for their density),[8] but brittle, in a polymer matrix, which is tough but neither particularly stiff nor strong. [9].

Almost Every structures are designed with respect to time centered and fatigue analysis methods. But with the help of frequency based fatigue analysis approach, the stress and strain response related to the applying load be found out and easily predict the optimized fatigue life and has many advantages over other methods of predicting the potentially inadequate simplified version and, and more computationally efficient fatigue analysis procedure. [10]
For considering the popular engineering difficulties, loading to the structures places the top position with respect of the design.[11]These problems be overruled by knowing the Gaussian approach of deforming. Fortunately, most engineering processes conform reasonably well to these assumptions.[12]
The starting point for any fatigue analysis is the response of the structure or component, which is usually expressed as a stress or strain time history. [13]By referring S-N diagram, a stress and strain cycle of fatigue design was made. However, because real signals rarely conform to this ideal constant amplitude situation, an empirical approach is used for calculating the damage caused by stress signals of variable amplitude. [14]

2. DESCRIPTION

Fatigue was a major factor to consider while designing any component. Basically three test were to conducted with different fabrication criteria and the composition of fibers and resin. Here for all the four fabrications same fibers and resins are used with different composition and orientations.

TECHNIQUES USED:

Fatigue test can be done by various methods.

1. Tensile fatigue test.
2. Compression fatigue test.
3. Shear fatigue test

Mounting Bracket Design

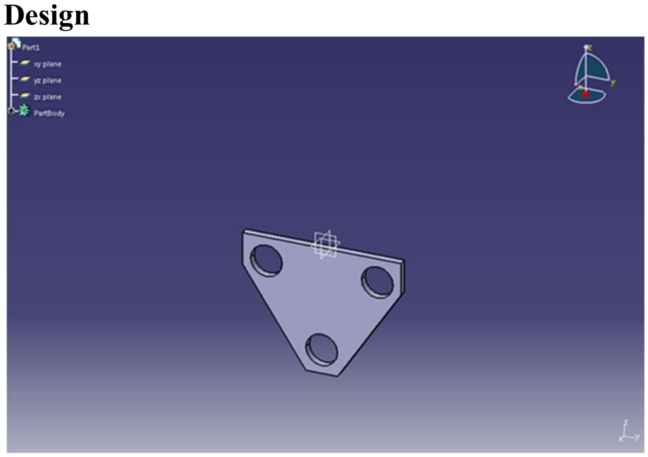

Fig 2.1: CATIA model of mounting brackets for structural assembly

3. PERFORMANCE ANALYSIS

The mounting brackets that are manufactured by Glass fibre (10 MIL E-Glass) and Epoxy resin (Araldite 257) to analyse the fatigue life.

For laminate 1

Specifications of material:

No. of Lamina (Plies) in a specimen = 08
Name of the Material = 10 MIL E – Glass
Name of the Resin = Araldite GY 257
Name of the Hardener = C2963
Specimen Dimension = 150 x 150 mm
Specimen Thickness = 2 mm.

Fabrication of mounting brackets and Preparation of test specimen for laminate 1

Fig.3.1 Fabrication of mounting brackets

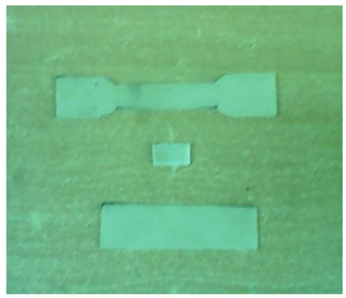

Fig 3.2 Before test

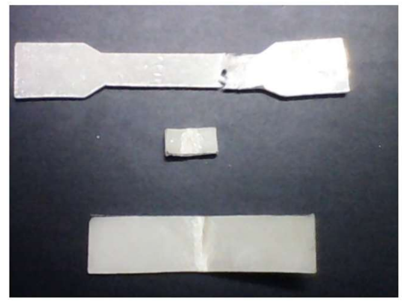

Fig 3.3 After test

3.2.1.4 Test results for laminate 1

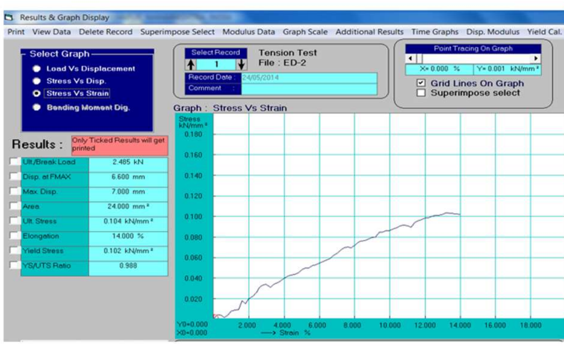

Fig 3.4 Tensile test for a laminate 1.

Fig 3.5 Flexural test for a laminate 1.

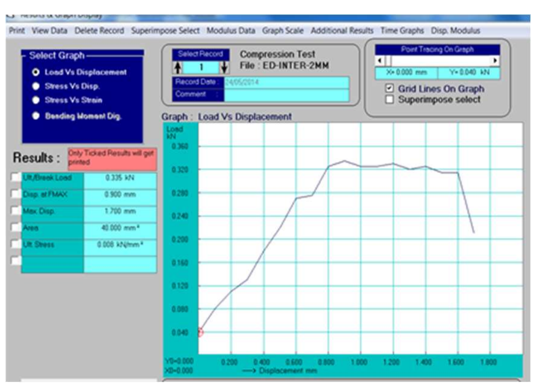

Fig 3.6 ILSS test for a laminate 1.

For laminate 2

Specifications of material:

No. of Lamina (Plies) in a specimen = 12

Name of the Material = 10 MIL E – Glass
Name of the Resin = Araldite GY 257
Name of the Hardener = C2963
Specimen Dimension= 150 x 150 mm
Specimen Thickness = 3 mm

Fabrication of mounting brackets and Test piece preparation for laminate 2


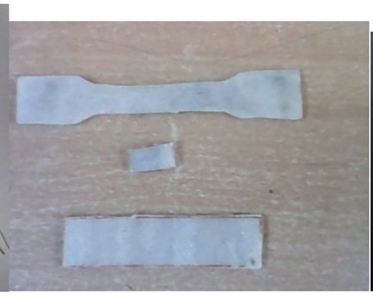


Fig.3.7 Fabrication of mounting brackets Fig 3.8 Before test Fig 3.9 After test

Test results for laminate 2


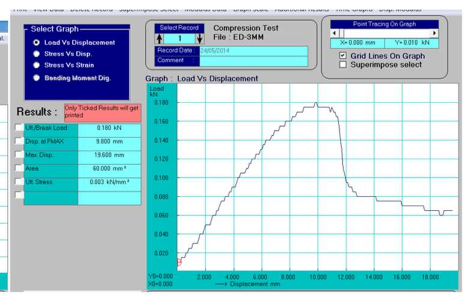

Fig 3.10 Tensile test for an laminate 2. Fig 3.11 Flexural test for an laminate 2.

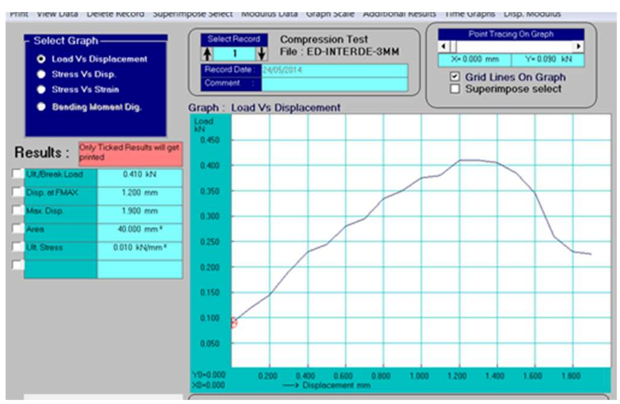

Fig 3.12 ILSS test for an laminate 2.

For laminate 3

Specifications of material:

No. of Lamina (Plies) in a specimen = 20
Name of the Material = 10 MIL E – Glass
Name of the Resin = Araldite GY 257
Name of the Hardener = C2963

Specimen Dimension = 150 x 150 mm

Specimen Thickness = 5 mm

Fabrication of mounting brackets for laminate 3

Fig.3.13 Fabrication of mounting brackets.

Fig 3.14 Debagging of laminate 3

Test piece preparation for laminate 3

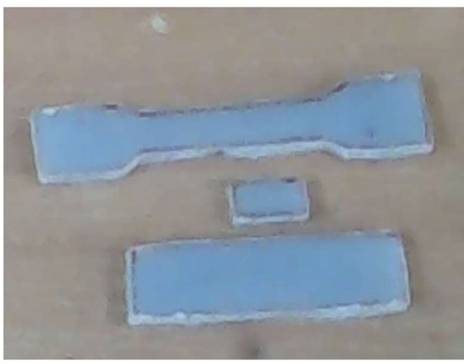

Fig 3.15 Before testing

Fig 3.16 After testing

Test results for laminate 3

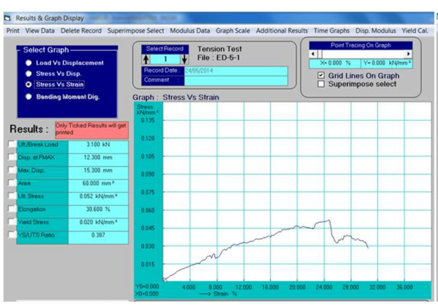

Fig 3.17 Tensile test for an laminate 3.

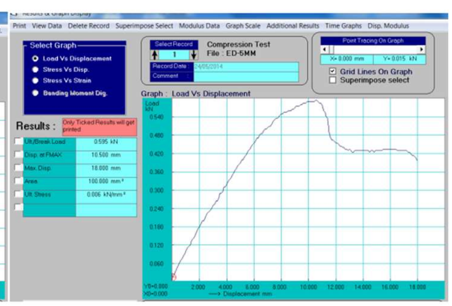

Fig 3.18 Flexural test for an laminate 3.

For laminate 4

Specifications of material:

No. of Lamina (Plies) in a specimen = 20 (Cross ply orientation).

Name of the Material = 10 MIL E – Glass

Name of the Resin = Araldite GY 257

Name of the Hardener = C2963

Specimen Dimension = 150 x 150 mm
Specimen Thickness = 5 mm

Laminate preparation for laminate 4

Test results

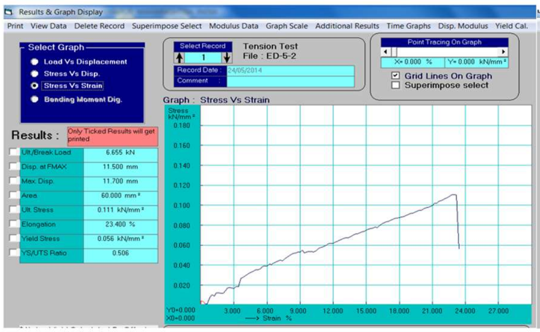

Fig 3.21 Tensile test for a laminate 4.

Fig 3.22 Flexural test for an laminate 4.

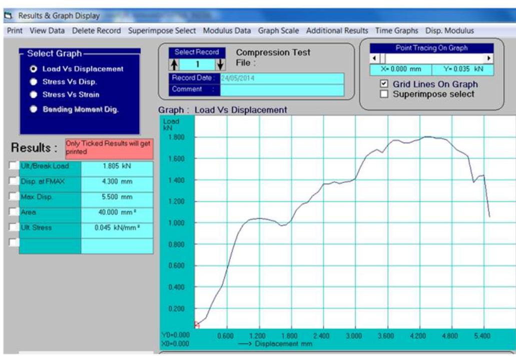

Fig 3.23 ILSS test for a laminate 4.

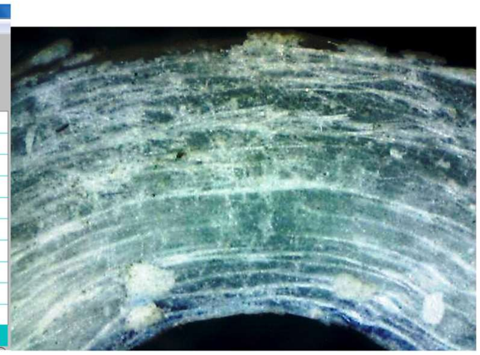

Fig 3.24 Macroscopic image of ILSS test

Mounting Bracket

Fig 3.25 Mounting bracket

4. FORMULA USED TO FIND NO. OF CYCLES TO FAILURE:

$$\frac{\Delta\varepsilon_{eq}}{2} = \frac{\sigma_f^{/} - \sigma_m}{E}(2N_f)^b + \varepsilon_f^{/}(2N_f)^c$$

b = - 0.067 (Shear fatigue strength exponent)
c = - 0.500 (Shear fatigue ductility exponent)
σf ′ = 0.8 KN/mm2 (Fatigue strength coefficient)
Sy = 0.4 KN/mm2 (Material yield stress)
Su = 0.501 KN/mm2 (Material ultimate stress)
ε f ′ = 0.009 (Fatigue strain coefficient)
K ′ = 0.81 KN/mm2 (Cyclic strength coefficient)
E = 5 KN/mm2 (Young's modulus)

Properties of Glass Epoxy:

Density	= 2.1 g/cm3
Longitudinal modulus E1	= 60GPa
Transverse modulus E2	= 13GPa
Shear modulus G12	= 3.4GPa
Poisson ratio	= 0.3

4.3. Model calculation:
ϵ = Δl/l =11.70/120 = 0.0975
So,
0.0975/2 = 800–111/5000 x (2Nf)-0.067 + 0.009 x (2Nf)-0.5
Then,
0.03 = 0.1378 x 0.955 (Nf)-0.067 + 0.009 x 0.707 (Nf)-0.5
0.0048 = 132 x 10-3 (Nf)-0.067 + 6.363 x 10-3 (Nf)-0.5
Nf = 3.017 x 106(cycles)
Summary:
Fatigue life of the SAE 1045 steel is
Nf = 0.1449 x 103(cycles)
Fatigue life of the mounting bracket (Glass fibre (10 MIL E-Glass) and Epoxy resin (Araldite 257) for 5mm (cross piy laminate) is
Nf = 3.01 x 106(cycles)

5. CONCLUSION:

No. of cycle to failures for the fatigue analysis of mounting brackets by using composite materials has been increased. This project explains about the Fatigue analysis of Mounting Brackets. The No. of cycles to failure of the composite material [Glass fibre (10 MIL E-Glass) and Epoxy resin (Araldite 257)] for mounting brackets has been increased by changing the thickness and the orientations of fibre.

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