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Fracture Analysis Of Fuselage And Wing Joint

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ABSTRACT

The main aim of this thesis is to investigate the fatigue crack and growth by fracture analysis in an aircraft fuselage and wing joint by determining the stress intensity factors, deformation and compared with alloy and composite materials. The materials considered are Al 6061, E- glass fiber, aramid fiber, technetium. 3D modeling will be done in Creo and fracture analysis will be done in Ansys 14.5.

INTRODUCTION

The body is Associate in nursing aircraft's main body section. It holds crew, passengers, and cargo. In single-engine craft it'll typically contain Associate in nursing engine, as well, though in some airplane the one engine is mounted on a pylon connected to the body that successively is employed as a floating hull. The body conjointly serves to position management and stabilization surfaces in specific relationships to lifting surfaces that is needed for craft stability and maneuver ability.

Fig - Douglas Sky raider

Rib

In A craft, ribs are forming components of the structure of a wing, particularly in ancient construction.

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By analogy with the anatomical definition of "rib", the ribs attach to the most spar, and by being perennial at frequent intervals, type a skeletal form for the wing. Sometimes ribs incorporate the device form of the wing, and therefore the skin adopts this form once stretched over the ribs

Fig - Wing ribs of a de Havilland DH.60 Moth

LITERATURE REVIEW

Dinesh kumar K, Sai Gopala Krishna V.V, Syed Shariq Ahmed, Meer Abdul Irfan [1], Have designed a Wing-Bracket interaction that wasn't nonetheless designed by any of the trade. And calculable the fatigue lifetime of our Wing-Bracket attachment model. Here compared the fatigue lifetime of our model with 3 materials like Maraging Steel, Ti and Structural A36 steel. Among this 3 we've got verified that Maraging steel offers a lot of fatigue life compared to alternative 2 materials. For estimating the fatigue life created some hand calculations. Finally depicted the fatigue life with the assistance of Benjamin David Goodman Curve. The Structural element is intended and analyzed exploitation CATIA and ANSYS Software's. In analysis the most stress at that the element undergoes degradation/damage is calculated for various finish Conditions (loadings and stresses), which determines the fatigue lifetime of the element.

Md. Abdul Wajeed, Babu Reddy [2], included the linear static analysis of the partition frames alongside spar beam and fatigue harm estimation at the crucial location because of unsteady masses. Lugholes and bolt-holes area unit possible to expertise a lot of stress because of high stress concentration. Stress analysis is administrated finite component methodology. An area analysis is administrated to capture high stress magnitude and stress distribution. Frame experiences variable loading throughout flight conditions. A typical transport craft load spectrum is used for fatigue harm calculation. During a aluminiferous structure fatigue manifests itself within the type of a crack, that propagates. If the crack during a critic allocation goes overlooked it could lead on to a ruinous failure of the frame. Fatigue harm estimation are administrated exploitation constant amplitude S-N knowledge for varied stress ratios and native stress history at stress concentration.

Sriranga B.k1, Kumar .R2 [3], Civil transport craft is employed for ferry passengers from one place to a different. Craft could be a extremely complicated flying structure. Usually transport craft undergoes nominal manicuring flights. Throughout the flight once the utmost elevate is generated, the wings of the craft can bear highest bending moment. Stress analyses are going to be meted out for the given pure mathematics of the wing-fuselage attachment bracket. Finite part methodology is employed for the strain analysis. Within the current project, trials are going to be created to predict the fatigue lifetime of wing-fuselage attachment bracket in a very transport framing. In a very antimonial structure fatigue manifests itself within the style of a crack that propagates. Fatigue cracks can seem at the placement of high tensile stress locations. These locations are invariably of high stress concentration. Fatigue life calculation are going to be meted out for typical service loading condition exploitation constant amplitude S-N information for numerous stress ratios and native stress history at stress concentration. During this modeling CATIA V5 software system is employed and for analysis tool MSC/ PATRAN and MSC/ NASTRAN 2010.

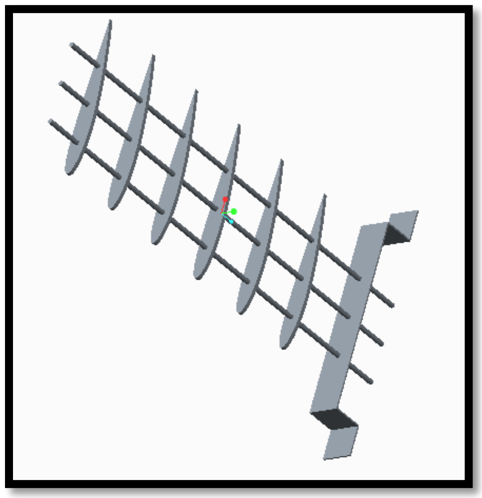

Fig: Final Assembly of Wing and Fuselage Joint

ANALYSIS OF WING JOINT

MATERIAL – ALUMINUM ALLOY 6061
FRACTURE ANALYSIS

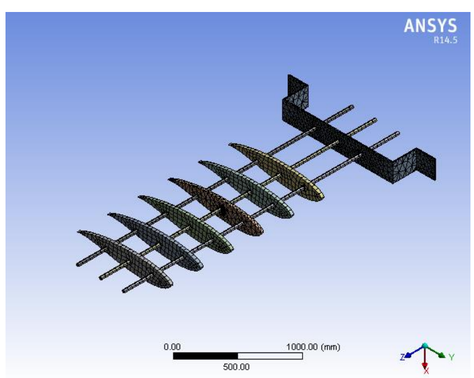

Fig – Meshed model of wing joint

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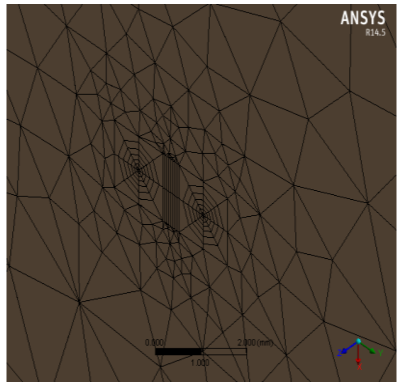

Fig – Crack

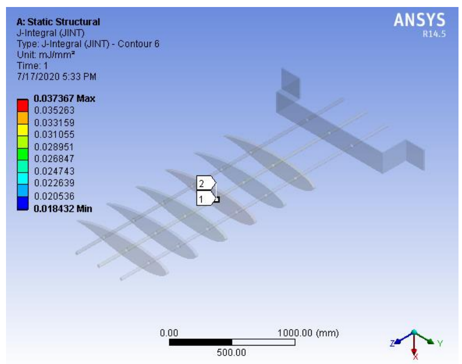

Fig – J – Integral on wing joint using Aluminum alloy 6061

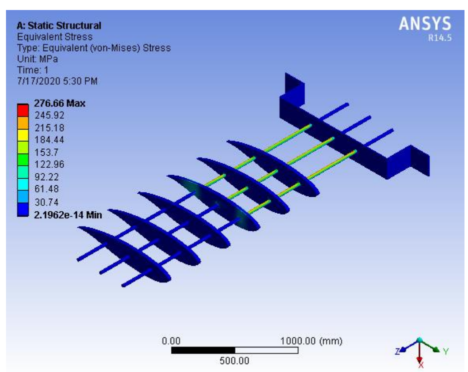

Fig – Equivalent Von-Mises Stress of wing joint using Aluminum Alloy 6061

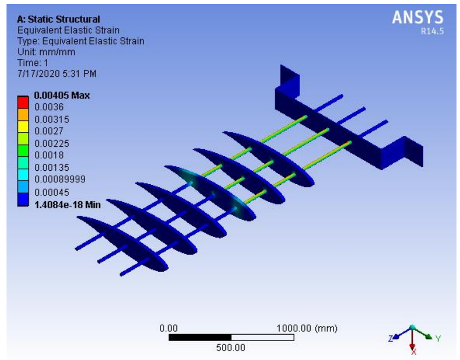

Fig - Equivalent Von-Mises Strain of wing joint using Aluminum Alloy 6061

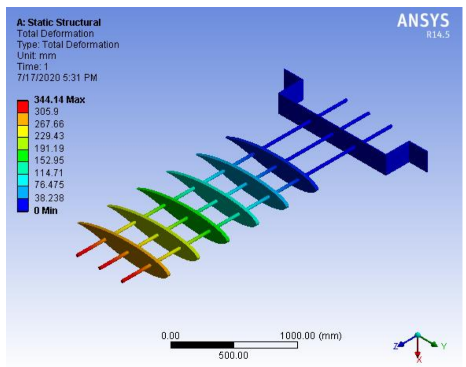

Fig - Total deformation of wing joint using Aluminum Alloy 6061

RANDOM VIBRATION ANALYSIS

Tabular Data

	Frequency [Hz]	Displacement [(mm²)/Hz]
1	6.2958	11.361
2	28.807	17.559
3	33.409	7.5803
4	35.684	8.9321
5	39.403	15.911
6	50.847	19.527
*		

Fig – tabular data

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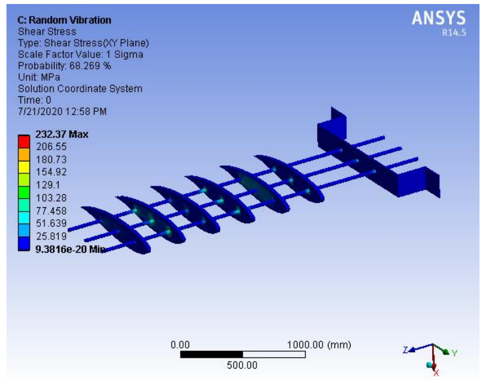


Fig – Shear Stress for Aluminum Alloy 6061

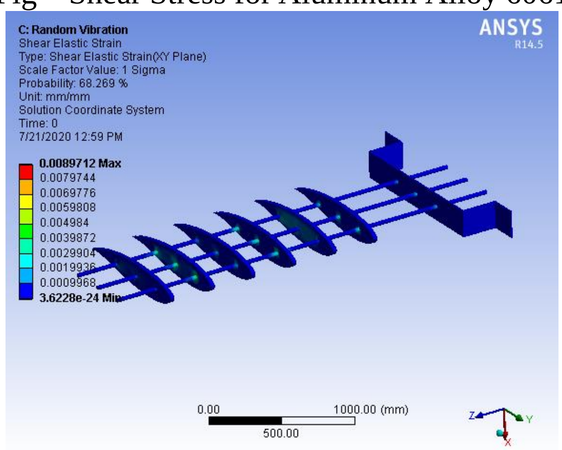


Fig – Shear Elastic Strain for Aluminum Alloy 6061

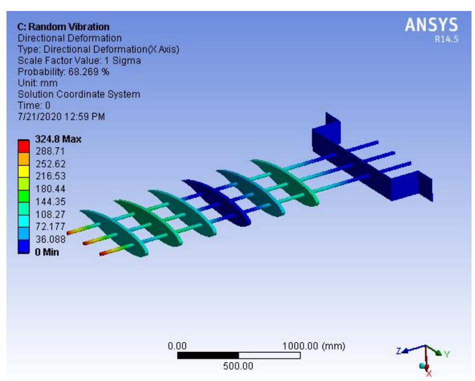


Fig – Directional Deformation for Aluminum Alloy 6061

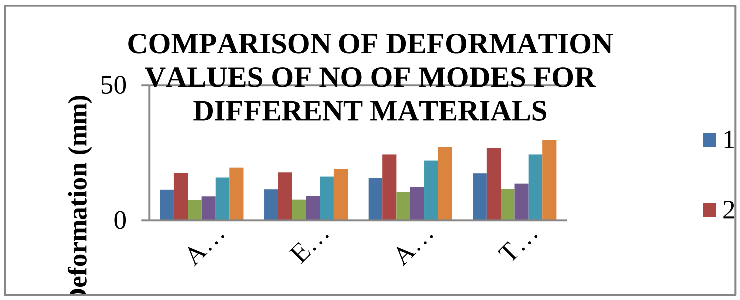
RESULTS

Material	Deformation (mm)	Stress (MPa)	Strain	Stress Intensity factor (Mpa.mm$^{0.5}$)			J-Integral (mj/mm^2)
				SIF 1	SIF 2	SIF 3	
Aluminum Alloy 6061	344.14	276.66	0.00405	43.065	9.2244	-2.2929	0.037367

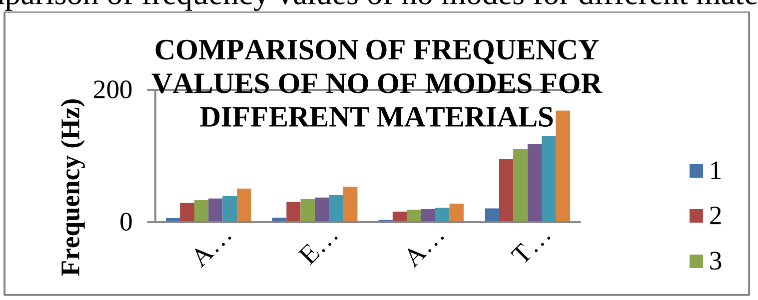
E glass fiber	328.66	276.02	0.0039688	41.219	8.0963	-1.4907	0.03404
Aramid fibers	21.539	276.69	0.025369	43.351	9.406	-2.4193	0.23452
Technetium	73.69	276.6	0.00086647	42.748	9.0443	-2.1665	0.0079679

MODAL ANALYSIS GRAPHS

Comparison of deformation values of no modes for different materials



Comparison of frequency values of no modes for different materials



RANDOM VIBRATION ANALYSIS

MATERIALS	Directional Deformation (mm)	Shear Stress (MPa)	Shear Strain
Aluminum Alloy 6061	324.8	232.37	0.0089712
E glass fiber	335.16	150.04	0.0049737
Aramid fibers	286.13	34.974	0.0085845
Technetium	731.78	2282.5	0.018572

CONCLUSION

A semi elliptical crack with radius of mm is given at the joint of wing and cylinder. Fracture analysis, static structural analysis, modal analysis and Random vibration analysis is done using materials Aluminum alloy, E glass fiber, Aramid fiber (Kevlar 49M) and technetium.

By observing fracture analysis results, the stress intensity factor is less when E glass fiber is used and more when aramid fiber is used. But the variation between all those is very minute between all the materials.

By observing static structural analysis results, stress is more when aramid fiber is used. The stress is increasing for aramid fiber by about 2% when compared with Aluminum alloy, by about

3% when compared E glass Fiber and by about 1.5% when compared with technetium. The stress value is less when technetium is used but the deformation is also less when it is used.

By observing modal analysis results, the frequency is less when Aramid is used and more when technetium is used. The frequency is increasing for technetium by about 35% when compared with Aluminum alloy, by about 45% when compared E glass fiber and by about 70% when compared with Aramid fiber. Due to the increase of frequencies, the vibrations will be more when technetium is used.

By observing random vibration analysis results, the shear stress is less when Aramid is used due to lesser frequency values and more when technetium is used due to higher frequency values. The shear stress is increasing for technetium by about 67% when compared with Aluminum alloy, by about 81% when compared Carbon Fiber and by about 97% when compared with Aramid. So it can be concluded that using Aramid fiber (Kevlar 49M) sustains more life than other materials due to initiation of a crack at the wing and fuselage joint.

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