GRAPHANE NANOPLATES' EFFECT ON THE STRUCTURAL PROPERTIES OF AIRCRAFT FLAPS

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AbstractGraphenenanoplates, because to their outstanding properties, are finding increasing usage in aerospace engineering. Graphenenanoplates are used in aerospace applications to alleviate problems including lightning strikes, ice accumulation, and other structural impact loads. Adding graphenenanoplates to the wing construction increases its resistance to corrosion. Aircraft wings experience tensile and compressive loads during flight, which may lead to failure before the yield point is reached. In this research, graphenenanoplates are integrated into the wing structure to enhance the structural behaviour of aircraft wings. CATIA is used to simulate the wing's structure, which is made up of composite materials such ribs, spars, and graphenenanoplates. Deformation, stress, strain, and other mechanical data are shown as a consequence of the tests.

IINTRODUCTION

An aircraft's wings carry the weight of the plane andareintendedtoliftitintotheair.Anyspecificaircraft's wingconfigurationisdeterminedbyavariety of elements, including size, weight, intendedusage, desired speed during takeoff and landing, anddesired rate of ascent. The left and right sides of theoperator's seat in the cockpit correspond to the leftand rightwingsofanaircraft,respectively.

Often wings are of full cantilever design. This meansThey are designed to eliminate the requirement forexternal bracing. Internal structural parts (spars andribs) and the aircraft's skin help sustain them. Otheraircraft wings employ wires or external struts to helpwith wing support, load carrying, and aerodynamicandlandingloads.Themajorityofwingsupportcables and struts are constructed of steel. Fairings arecommonlyfoundonstrutsandtheattachingfittings to lessen drag. Jury struts are located on struts thatconnect to the wings far from the fuselage and areshort, almost vertical supports. This helps to reduceoscillation and movement of the strut brought on byairflowaroundthestrutduring flight.

Examplesofexternallybracedwings,commonlyreferred to as semi-cantilever wings, are shown in theimage below. Also demonstrated are cantilever wingswithoutanyexternal bracing.

Althoughwoodcoatedinfabricandoccasionallymagnesium alloys have been utilised, aluminium isthe mostpopularmaterialformaking wings.

In the building of their wings and throughout theirairframes, modern aircraft frequently use lighter andstronger materials. There are wings composed of acombinationofmaterialsforthebeststrengthtoweight performance as well as wings built solely ofcarbonfibreorothercompositematerials.

II LITERATURESTUDIES

Yii-Mei Huang et al [1] focuses on the passive soundmanagement method. Their major goal was to createdynamicdampeningabsorbersthatwouldreducevibrations caused by things like propellers and otheroutside impacts on the fuselage. In order to limit thevibrations and noise produced by the absorbers to aminimum, they analysed the proper parameters to beselected throughoutthedesignphase.

ParthaDeyetal[2]comprehendshowstablecomposite skew plates are under stresses. Four-nodedshearflexiblequadrilateralplateswereusedtoexaminethedynamicstabilityofcompositeskewplates.Theplate'sfiniteelementequationsweredeveloped.Matrixcalculationsforelementalmass and linear-geometric stiffness were performed usingtheGaussianintegrationrule.

ZhiquanLIetal[3],plannedtobuilda full-spanmodel tiltrotor and analyse it using the parameter ofaeroelasticstabilityinflightusingpasttiltrotorresearch as a foundation. Additionally, they definedthe distinctions between a semi- and full-span model,pinpointed the causes of its instability, and kept trackof how surrounding structures affected its aeroelasticstability.Theycreatedalgorithmstorepresent differenttiltrotorarchitecturesandcharacteristicsafterbuildingatheoreticalmodelofthetiltrotor.

III METHODOLOGYUSED

FiniteElementAnalysis(FEA)

R.Courantcreatedthefirstversionofthefiniteelement analysis (FEA) in 1943. He used the Ritztechniqueofnumericalanalysisandvariationalcalculusreductiontofindapproximationsofsolutionstovibrationsystems.Amorecomprehensive definition of numerical analysis wassoon created in a work written by M. J. Turner, R. W.Clough, H. C. Martin, and L. J. Top and published in1956.The"stiffnessanddeflectionofcomplexstructures"wasthemainfocus ofthearticle.

A computer model of a material or design that hasbeenstrainedandexaminedforcertainoutcomesmakesupFEA.Boththecreation ofnew productsandtheimprovementofalreadyexistingproductsemployit.Priortoproductionorconstruction,acorporation can confirm a suggested design would beabletomeettheclient'srequirements.Ancurrentproductorstructurecanbemodifiedtomeettherequirements of a new service condition. FEA may beemployedtoassist in deciding how tomodify thedesignintheeventof structural failure.

The two main forms of analysis utilised in businessare 2-D modelling and 3-D modelling. Even though2-D modelling keeps things simple and enables theanalysis to be conducted on a reasonably standardcomputer, it typically produces less precise findings.However, 3-D modelling yields more precise findingsattheexpenseofbeingineffectiveonallbutthefastestprocessors.Programmerscanaddavarietyof algorithms(functions)toanyofthesemodellingframeworkstoinfluencethesystem'slinearornonlinear behaviour. In general, linear systems are farlesscomplicatedanddonotaccountforplasticdeformation.Plasticdeformationistakenintoconsideration by non-linear systems, and several ofthemcantestmaterialsallthewayto fracture.

A mesh is a gridmade up of a complicated networkofnodes,orpoints,thatareusedinFEA.Thematerial and structural qualities that determine howtheconstructionwillrespondtodifferentloadingcircumstances are encoded into this mesh. Dependingon the expected amounts of stress in a specific place,nodesaredistributedthroughoutthematerialatacertain density.A highernode density is typicallyfound in areas that will encounter more stress thanthose that would receive little to no load. The fracturepoint of previously testedmaterial, fillets, corners,intricate details, and high stress zones are possiblepoints of interest. Because a mesh element extendsfrom each node to each of the surrounding nodes, themeshbehaveslike aspiderweb.

IV STATIC ANALYSIS OF AIRCRAFTWINGWITH RIBS AND SPARS

CASE1:ANALYSISOFAIRCRAFTWINGWITH OUTGRAPHENECOATING

Material-graphiteepoxy

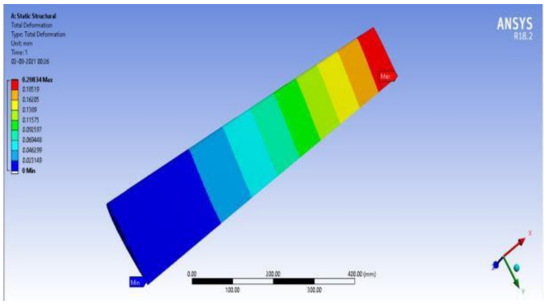


Fig1: Deformation

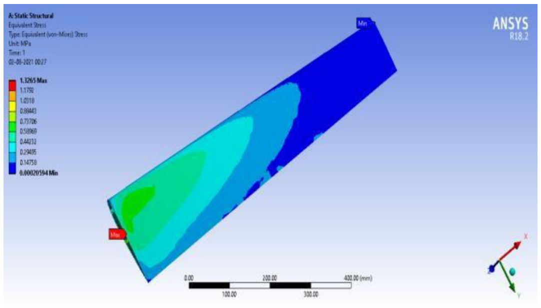


Fig2: Stress

MATERIAL-KEVLAREPOXY

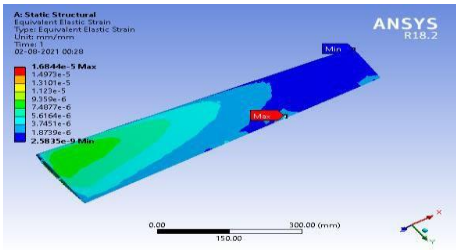


Fig 3:StrainMATERIAL-KEVLAREPOXY

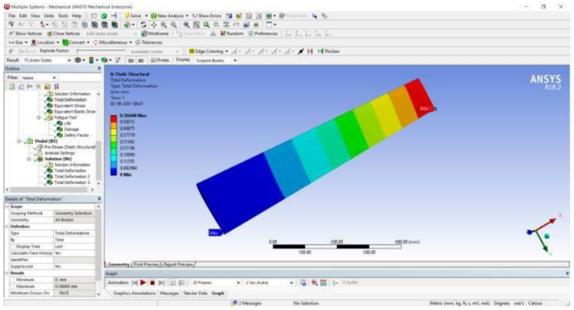


Fig4: Deformation

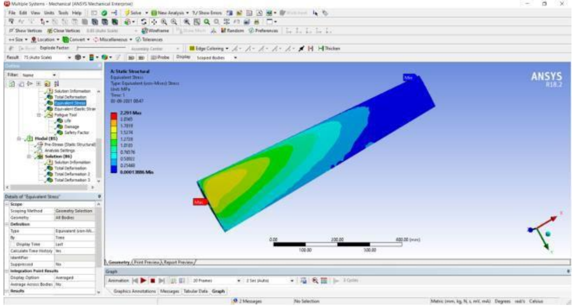


Fig5: Stress

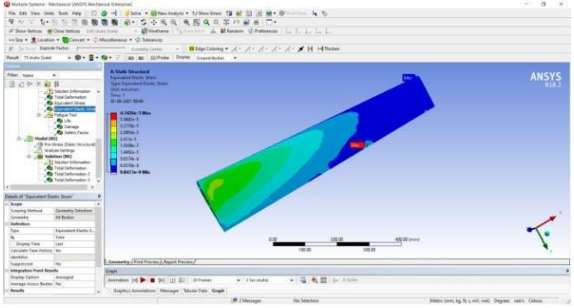


Fig6: Strain

MATERIAL- GLASSFIBER

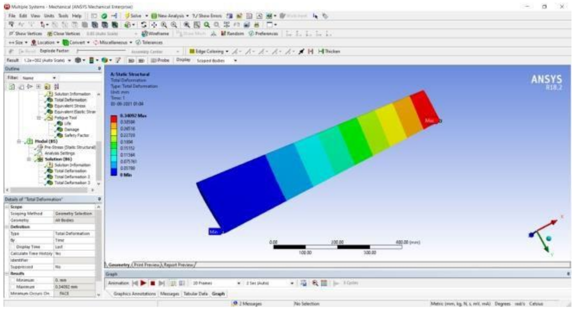


Fig7: Deformation

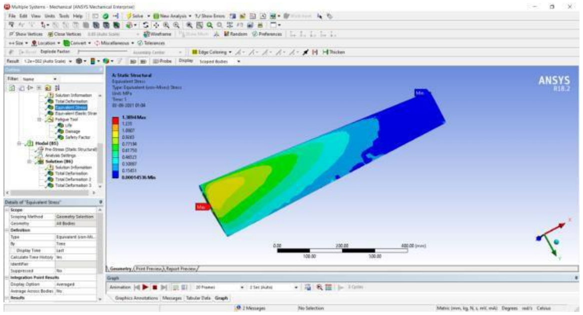


Fig8: Stress

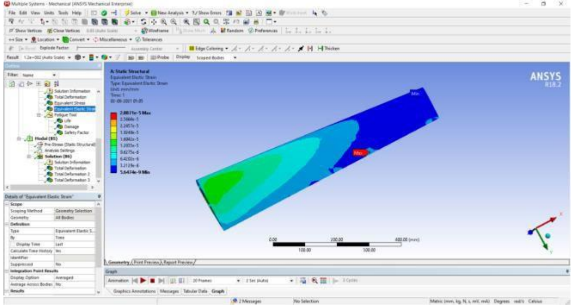


Fig9: Strain

FATIGUEANALYSISOFAIRCRAFTWINGWITH RIBSAND SPARS

MATERIAL-GRAPHITEEPOXY

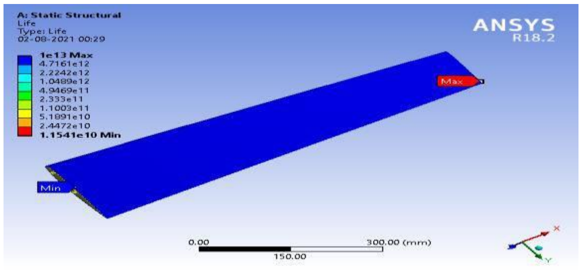


Fig10: Life

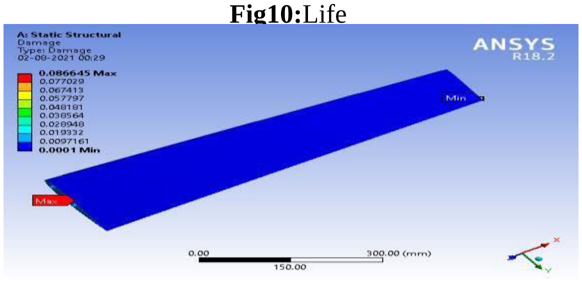


Fig11: Damage

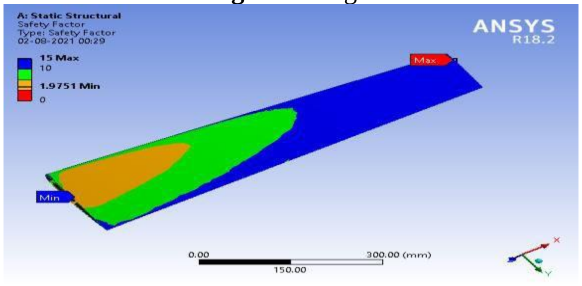


Fig12: Safetyfactor

MATERIAL-KEVLAREPOXY

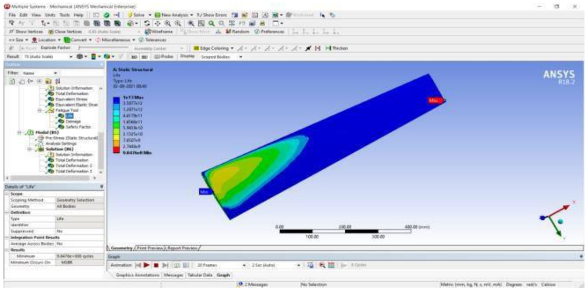


Fig13: Life

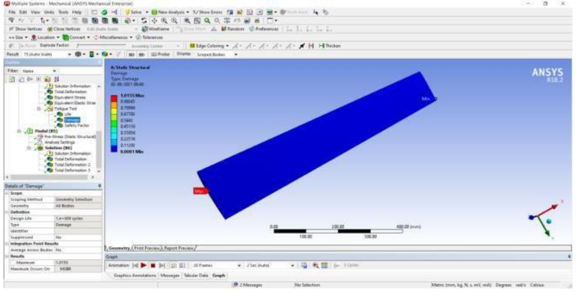


Fig14: Damage

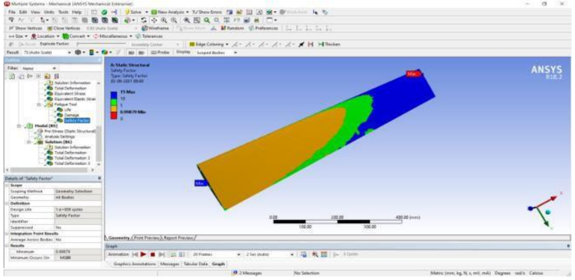


Fig15: Safetyfactor

MATERIAL- GLASSFIBER

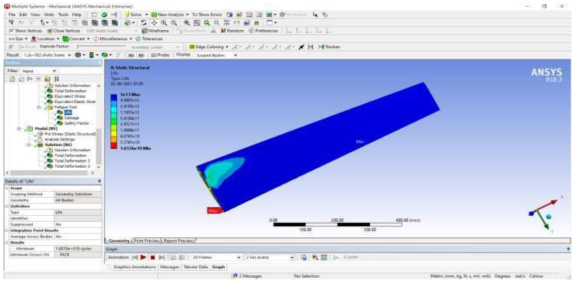


Fig16: Life

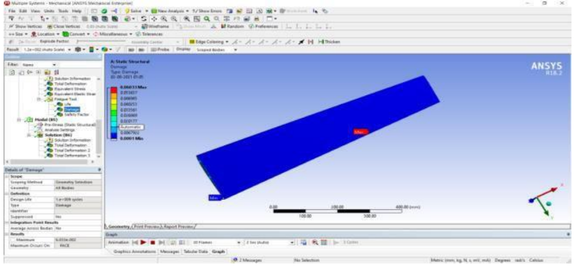


Fig17: Damage

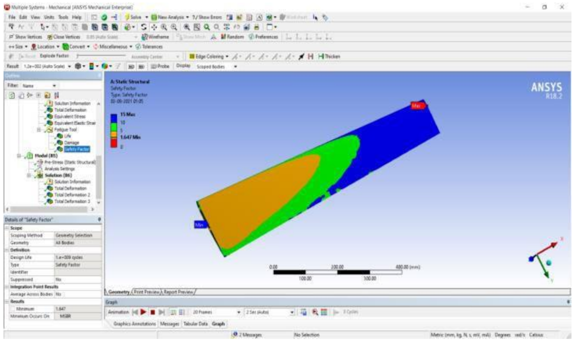


Fig18: Safetyfactor

MODALANALYSISOFAIRCRAFTWINGWITH RIBSAND SPARS

MATERIAL-GRAPHITEEPOXY

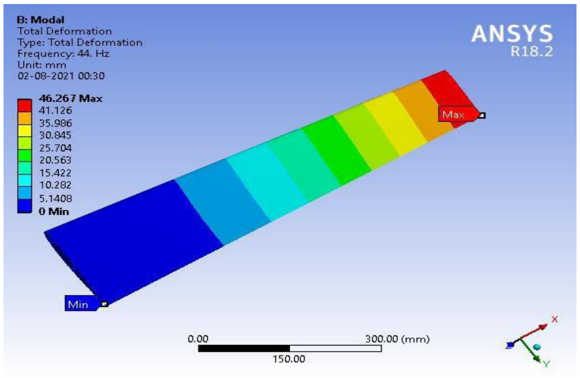


Fig19: Modeshape-1

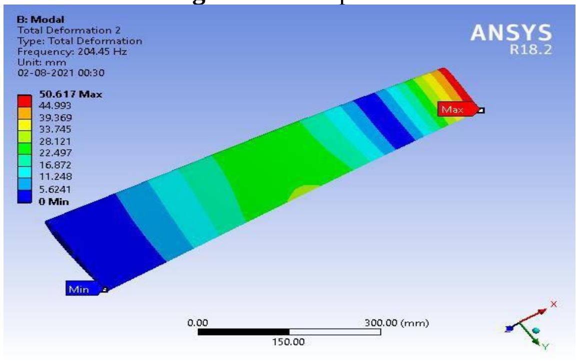


Fig20: Modeshape-2

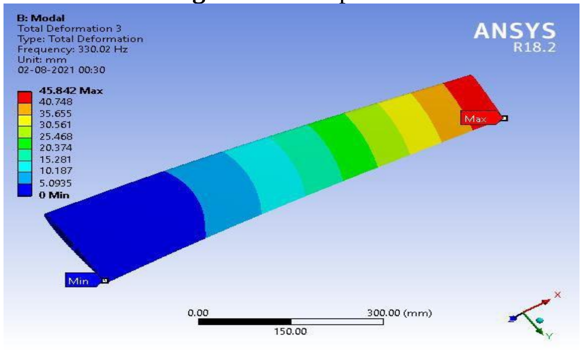


Fig21: Modeshape-3

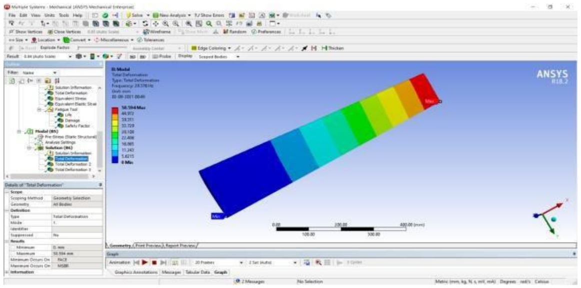


Fig22: Modeshape1

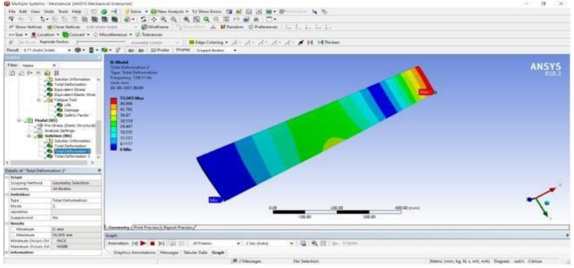


Fig23: Modeshape2

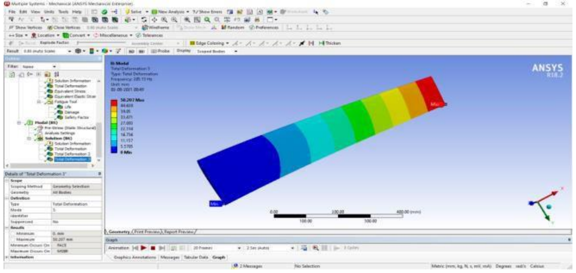


Fig24: Modeshape3

MATERIAL- GLASSFIBER

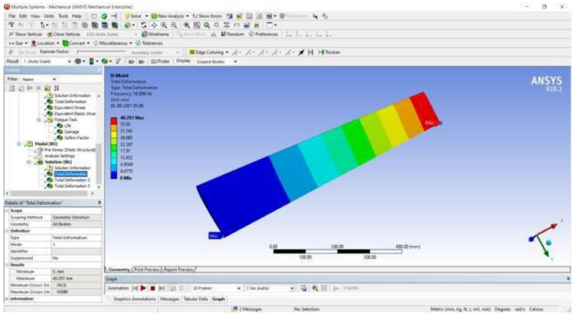


Fig25: Modeshape1

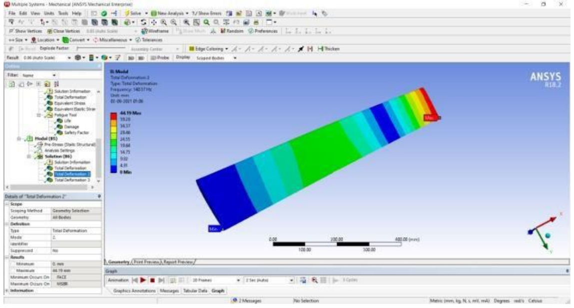


Fig26: Modeshape2

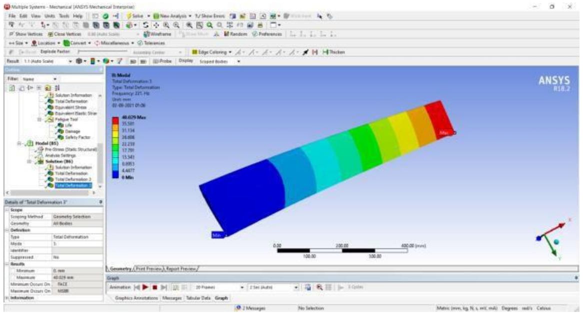


Fig 27: Mode shape3

ANALYSIS OF AIRCRAFT WING WITHGRAPHENECOATING

STATICANALYSISOFAIRCRAFTWINGWITH RIBSAND SPARS

MATERIAL-GRAPHITEEPOXY

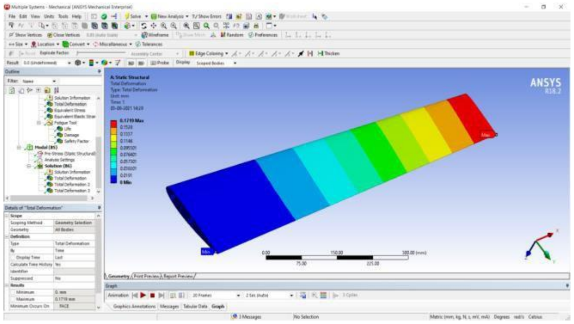


Fig28: Deformation

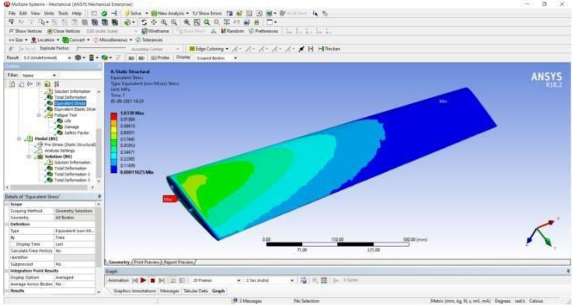


Fig 29: Stress

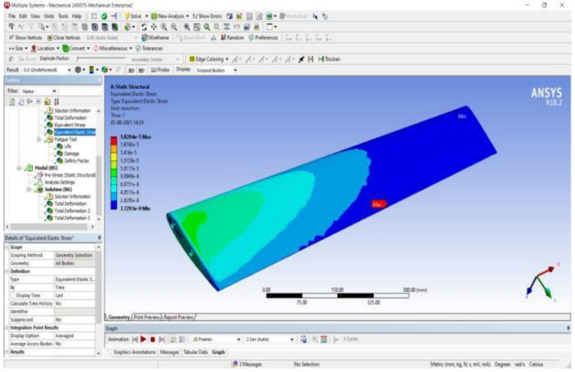


Fig 30: Strain

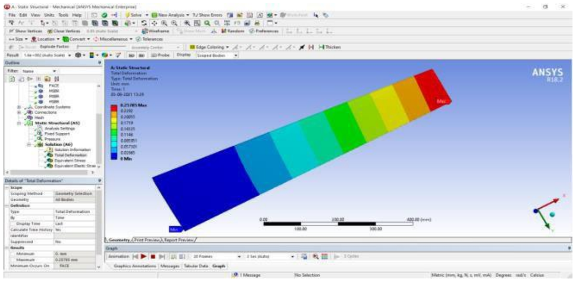


Fig31:Deformation

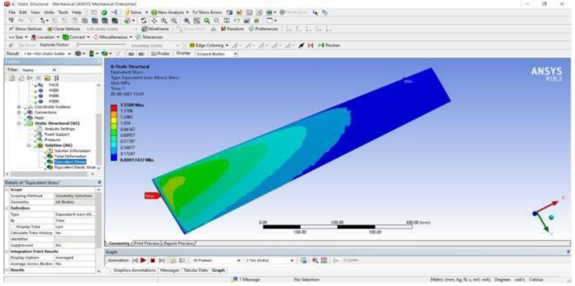


Fig 32:Stress

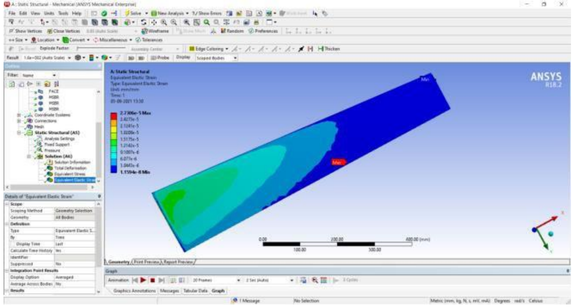


Fig 33:Strain

MATERIAL- GLASSFIBER

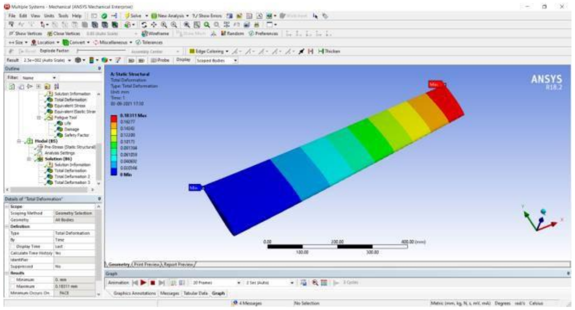


Fig34:Deformation

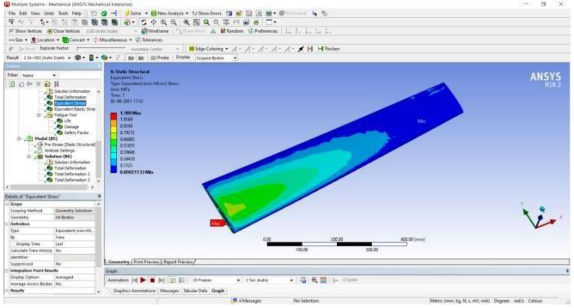


Fig 35:Stress

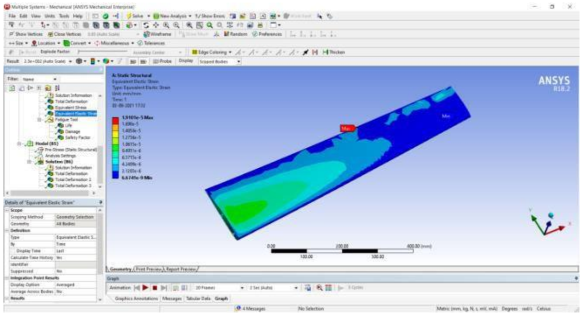


Fig 36:Strain

Material-aluminiumalloy

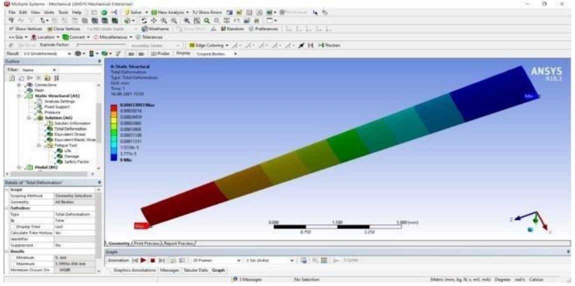


Fig37:Deformation

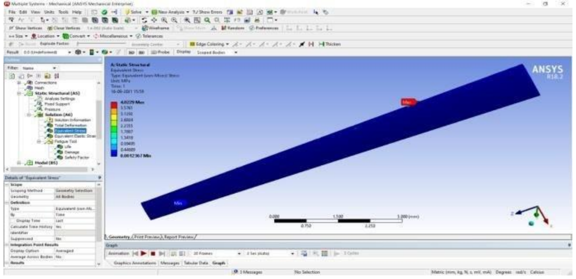


Fig 38:Stress

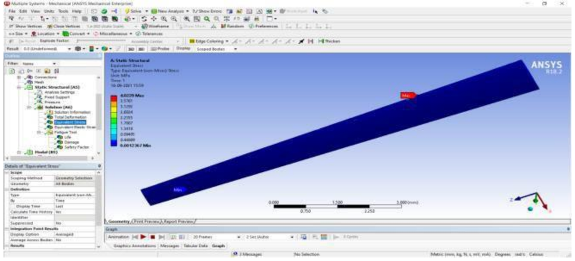


Fig 39:Strain

FATIGUEANALYSISOFAIRCRAFTWINGWITH RIBSAND SPARS

MATERIAL-GRAPHITEEPOXY

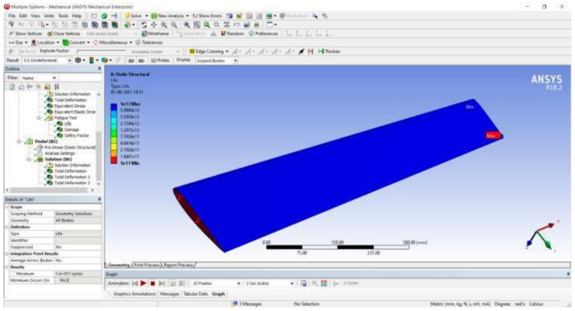


Fig40:Life

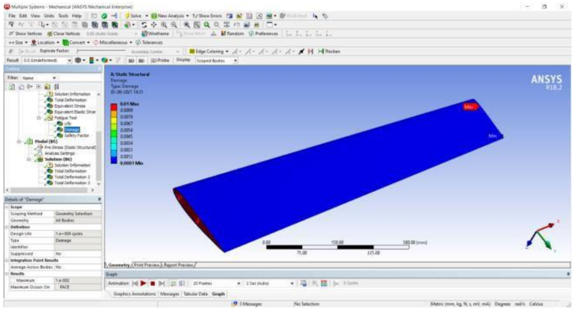


Fig41: Damage

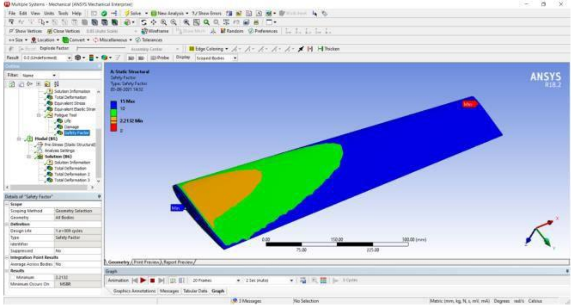


Fig42: Safetyfactor

MATERIAL-KEVLAREPOXY

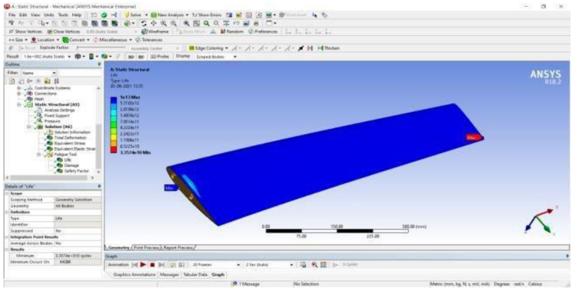


Fig43: Life

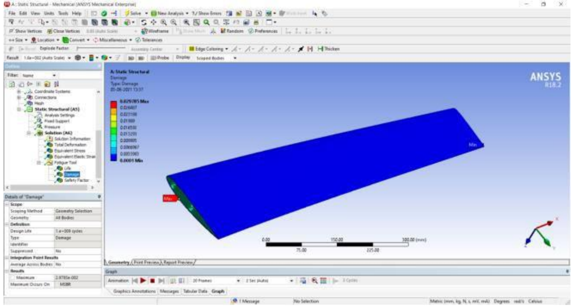


Fig44: Damage

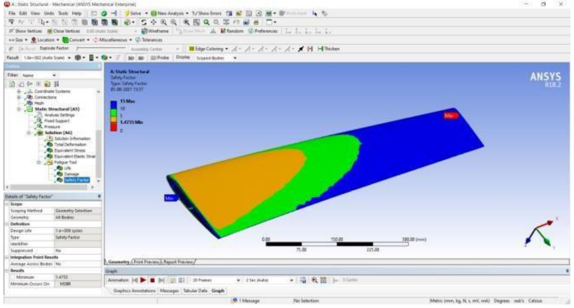


Fig45: Safetyfactor

MATERIAL- GLASSFIBER

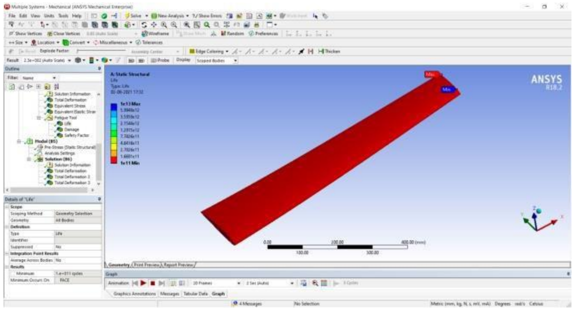


Fig46: Life

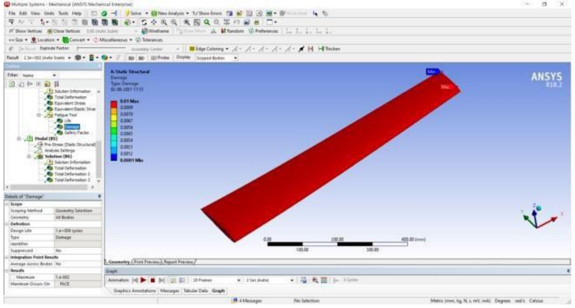


Fig47: Damage

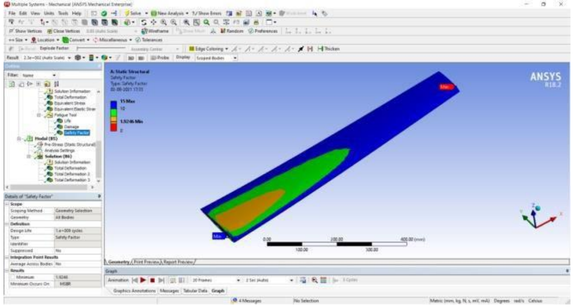


Fig48: Safetyfactor

Material–aluminiumalloy

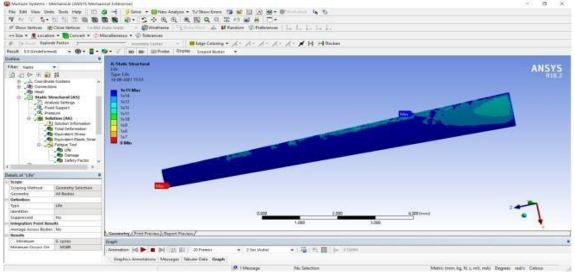


Fig49: Life

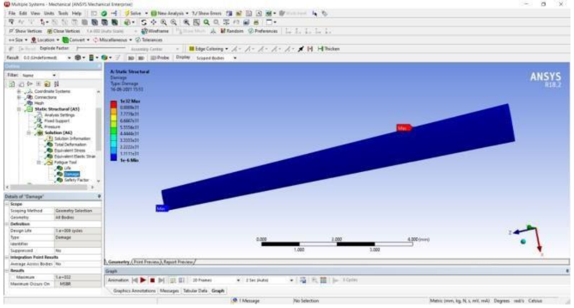


Fig50: Damage

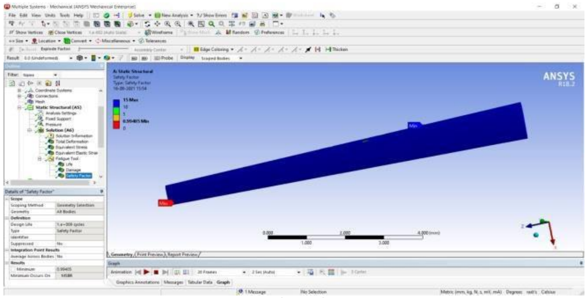


Fig51: Safetyfactor

MODALANALYSISOFAIRCRAFTWINGWITH RIBSAND SPARS

MATERIAL-GRAPHITEEPOXY

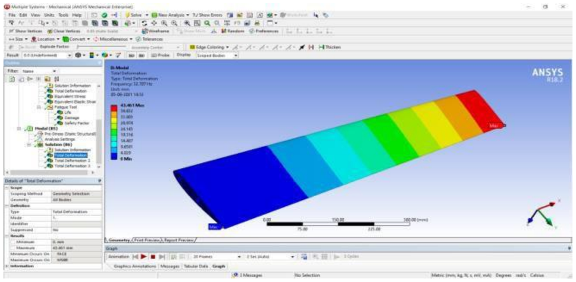


Fig52: Modeshape1

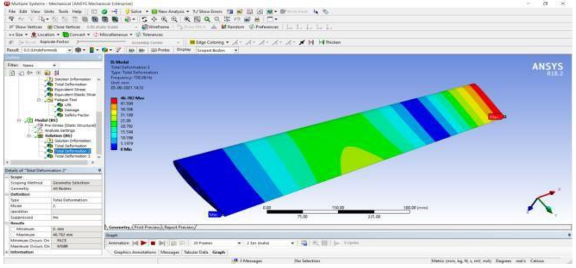


Fig53: Modeshape2

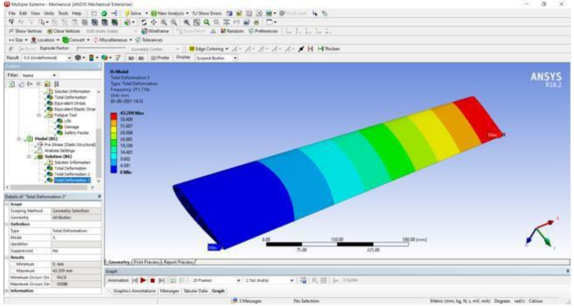


Fig54: Modeshape3

MATERIAL-KEVLAREPOXY

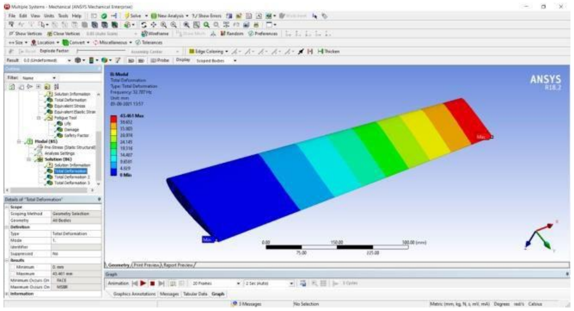


Fig 55: Mode shape1

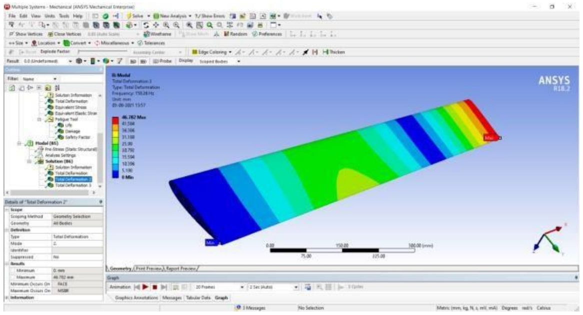


Fig56: Modeshape2

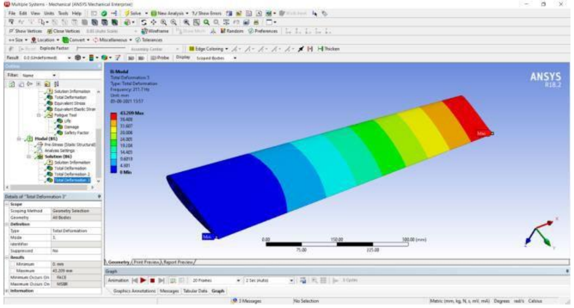


Fig57: Modeshape3

MATERIAL- GLASSFIBER

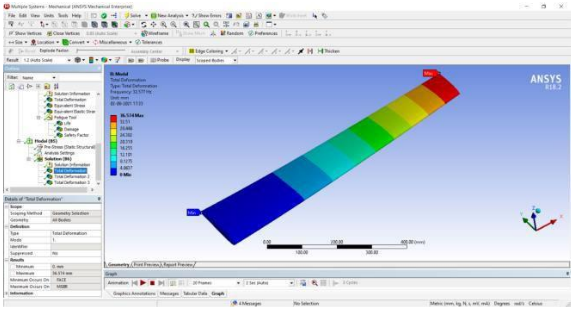


Fig58: Modeshape1

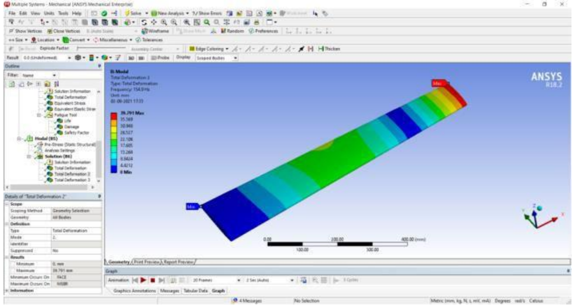


Fig59: Modeshape2

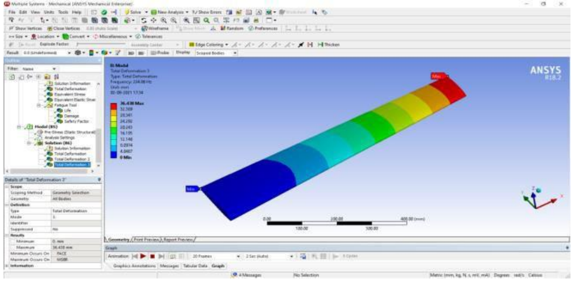
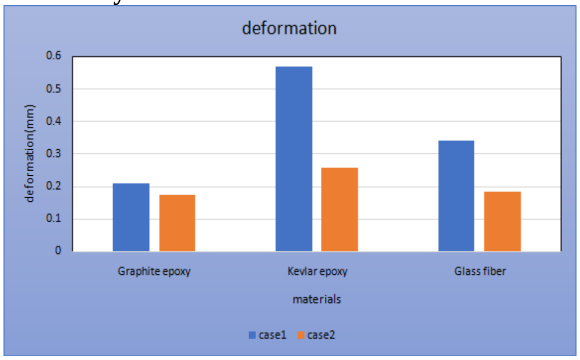


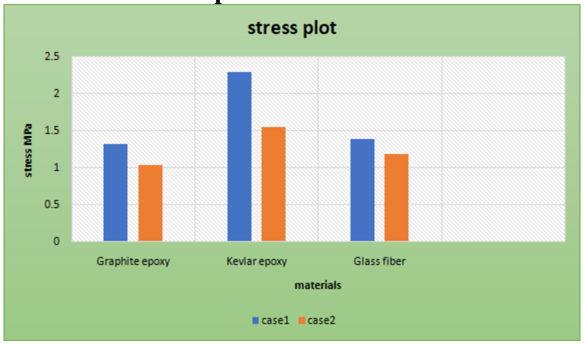
Fig60: Modeshape3

V RESULTSANDDISCUSSIONS

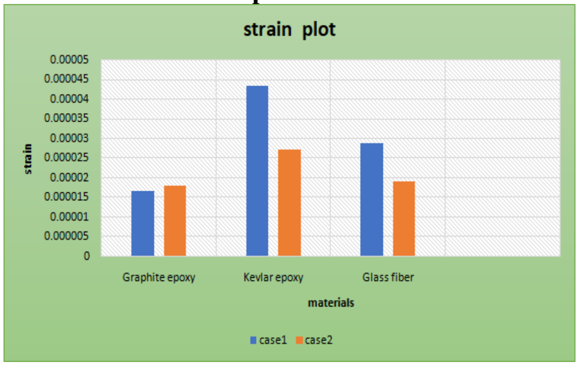
Staticanalysisresults



Graph1: Deformation

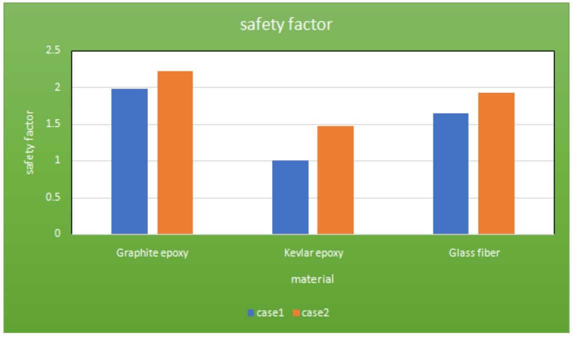


Graph2: Stress



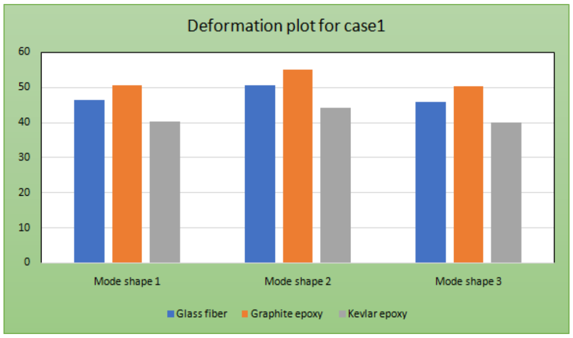
Graph3: Strain

Fatigueanalysisresults

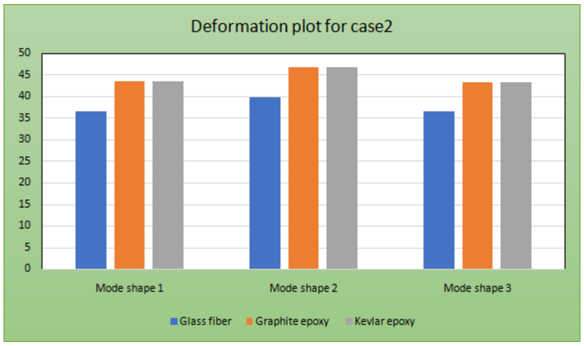


Graph4: Safetyfactor

Modalanalysisresults



Graph5: Deformationcase1



Graph6: Deformationcase2

VI CONCLUSIONS

The trainer aircraft wing structure with skin, spars,andribsistakenintoconsiderationforthefullanalysis is in this work. Two skinned spars and 15 ribsmake up the wing structure. The skin is made of analuminium alloy and has a graphene coating. Both thefrontandtherearsparshave"C"sections.Tocalculate the stresses and life at spars and ribs owingto the applied pressure load, a stress and fatigue studyofthe entirewingsectionisperformed.

Results from this experiment were compared to thoseof wings made of aluminium alloy and wings coveredwith graphene.

Materials including glass fibre, graphite epoxy, andKevlar epoxy were taken and placed to the ribs andspars. The wing skin is made of coated graphene andaluminiumalloy.

When compared to models and glass fibre and kevlarepoxy, the graphite epoxy material has less stress,according to static study of aircraft wings. Less stressispresentinwingsmadeofaluminiumalloyandcovered ingraphene.

Thedeformation,stress,andstrainvaluesforthealuminium alloy material at hand were compared tothosefor compositematerials.

When compared to composite materials, the currentmaterialhashigherstressvalues.

By looking at the modal analysis of an aircraft wing,onecanseethatthedeformationandfrequencyvalues are higher for thematerial Graphite epoxy.According to the fatigue study of an aircraft wing,graphiteepoxymaterialhasahighersafetyfactorvalue.

Theconclusion is thatthegraphite epoxy materialand the wings with aluminium alloy andgraphenecoatingaresuperiormaterials foraeroplane wings.

REFERENCES

[1] Yii-MeiHuang,Chun-ChengChen,Optimaldesign of dynamic absorbers on vibration and noisecontrolofthefuselage,Computers&Structures,Volume76, Issue 6, Pages691-702.

[2] PRAKASH, VODNALA VEDA, and BOMMANA SHRAVN KUMAR. "IMPROVING NANO MATERIAL COTING OF GAS TURBINE BLADES MODEL ANALYSIS."

[3] ZhiquanLi,PinqiXia,Aeroelasticstability offull-spantiltrotoraircraftmodelinforwardflight,Chinese Journal of Aeronautics, Volume 30, Issue 6,Pages1885-1894.

[4] PRAKASH, V. V., & KUMAR, B. S. IMPROVING ORC PLANT EFFICIENCY BY COMBUSTION PROCESS..

[5] Liang QU, Yinghui LI, Haojun XU, DengchengZHANG,GuoqiangYUAN,AircraftNonlinearStabilityAnalysisAndMultidimensionalStabilityRegion Estimation Under Icing Conditions, ChineseJournal of Aeronautics, Volume 30, Issue 3, Pages976–982.

[6] Wencheng Li, DongpingJin, Flutter suppressionandstability analysisforavariable-spanwingviamorphingtechnology,JournalofSoundand Vibration,Volume 412,Pages410-423.

[7] N. Siepenkötter, W. Alles, Stability Analysis OfTheNonlinearDynamicsOfFlexibleAircraft,AerospaceScienceandTechnology,Volume9,Pages135–141.

[8] C.Natale,G.Aurilio,G.DeMaria,ModalAnalysisAndVibrationControlOfAFuselageAeronauticalPanel,IFACProceedingsVolumes,Volume35, Issue 2, Pages117-122.

[9] Robert M. Hall, Impact of Fuselage Cross SectionOnTheStabilityOfAGenericFighter,NASALangleyResearchCenter,AIAA-98-2725.

[10] Wen Jing, Wang Yankui, Deng Xueying, AnExperimentalInvestigationOnStaticDirectionalStability,ChineseJournalofAeronautics,Volume29,Issue 6, Pages1527–1540.

[11] T.P. Ratvasky and R.J. Ranaudo, Icing Effectson Aircraft Stability and Control Determined fromFlight Data, 31st Aerospace Sciences Meeting andExhibit.

[12] FabrizioNicolosi, Agostino De Marco, PierluigiDellaVecchia,Stability,FlyingQualitiesAndLongitudinalParameterEstimationOfATwin-EngineCS-23CertifiedLightAircraft,AerospaceScienceandTechnology,Volume24,Pages226–240.

[13] Prakash, V. V. Use Of Ndt Approches For Radiator Fabrication And Reliability For Nano Fluids-A Study.

[14] MasoudMirzaei, Mohammad HadiKarimia,Mohammad Ali Vaziri, An Investigation of ATactical Cargo Aircraft Aft Body Drag ReductionBasedOnCFD AnalysisAndWindTunnelTests,Aerospace Science and Technology, Volume 23,Pages263–269.