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THE ANALYSIS ON LAMINATED COMPOSITE PLATE BY USING FINITE ELEMENT METHOD

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ABSTRACT:

In general most of structures are under severe static and dynamic loading and different constrain conditions during their service life. Finite element analysis is carried out to perform analysis on a laminated composite plate on either square (or) rectangular shape precisely by using ANSYS. A finite element model is proposed and developed based on first order shear deformation theory (FSDT). The element formulated is an 8-noded (or) SHELL181. The design is developed in uni-graphics Siemenns NX 8.0 and analysis is done in ANSYS work bench. The thermal heat flux generations developed between the layers

Keywords: Composite plate , different material , by using software's like ANSYS and others.

SCOPE OF WORK'

Today, composite laminates have many applications as advanced engineering materials, primarily as components in power plants, aircrafts, ships, civil engineering structures, cars, robots, rail vehicles, sports equipment, prosthetic devices, etc. The major attribute of composite material is capability of the controllability of fiber alignment. By arranging layers and fiber direction, laminated material with required stiffness and strength properties to specific design conditions, can possibly be achieved, Laminated composite materials are broadly utilized in aviation, barrier, marine, vehicle, and numerous different ventures. They are commonly lighter and stiffer than other basic materials. the design engineer must consider many design alternatives. It is essential to know the dynamic and buckling characteristics of such structures subjected to dynamic loads in complex environmental conditions. For example, when the frequency of the loads matches with one of the resonance frequencies of the structure, large translation/torsion deflections and internal stresses occur, which may lead to failure of structure components. The structural components made of composite materials such as aircraft wings, helicopter blades, vehicle axles and turbine blades can be approximated as laminated composite beams.

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OBJECTIVES OF THE STUDY

1. Excitation of a composite laminate plate by patch type piezoelectric actuators surface bonded to the structure.

2. Model has been applied to a simply supported cross-ply composite laminate plate excited by two piezoelectric actuators symmetrically bonded to both sides of the plate with time harmonic thermal loading.

3. Analytical expression of the thermal analysis of the simply supported composite laminate induced by the piezoelectric actuators.

4. Three-dimensional finite element analysis is to conduct using the commercial software ANSYS.

LITERATURE REVIEW

Reddy J.N., Chao W.Cused stiffness method for the solution of the purely in-plane free vibration problem of symmetric cross-ply laminated beams. The rotary inertia, axial and transverse shear deformation effects are considered in the mathematical model by the first-order shear deformation theory. A total of six degrees of freedom, four displacements and two rotations are defined for an element. The exact in-plane element stiffness matrix of 6×6 is obtained based on the transfer matrix method. The element inertia matrix consists of the concentrated masses. The sub-space iteration and Jacobi‟s methods are employed in the solution of the large-scale general eigenvalue problem.

Khedier A.A., Reddy J.Nintroduced a dynamic finite element method for free vibration analysis of generally laminated composite beams on the basis of first-order shear deformation theory. The influences of Poisson effect, couplings among extensional, bending and torsional deformations, shear deformation and rotary inertia are incorporated in the formulation. The dynamic stiffness matrix is formulated based on the exact solutions of the differential equations of motion governing the free vibration of generally laminated composite beam.

Hughes T.J.R., Tezduyar T.Eanalyzed the natural frequencies of composite tubular shafts using equivalent modulus beam theory (EMBT) with shear deformation, rotary inertia and gyroscopic effects has been modified and used for the analysis. The modifications take into account effects of stacking sequence and different coupling mechanisms present in composite materials. Results obtained have been compared with that available in the literature using different modeling. The close agreement in the results obtained clearly show that, in spite of its simplicity, modified EMBT can be used effectively for rotor-dynamic analysis of tubular composite shafts.

Reddy J.Npresented a general formulation for free and transient vibration analysis of composite laminated beams with arbitrary lay ups and any boundary conditions. A modified variational principle combined with a multi-segment partitioning technique is employed to derive the formulation based

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on a general higher order shear defomation theory. The material coupling for bending-stretching, bending-twist, and stretching twist as well as the poison‟s effect are taken into account.

PandyaB.N. ,.Kant Tproposed a new trigonometric zigzag theory for the static analysis of laminated composite and sandwich plates. This theory considers shear strain shape function assuming the non-linear distribution of in-plane displacement across the thickness. It satisfies the shear-stress-free boundary conditions at top and bottom surfaces of the plate as well as the continuity of transverse shear stress at the layer interfaces obviating the need of an artificial shear correction factor.

Somashekar B.R., PratapG.,RameshBabu .Cused analytical and finite element methods for prediction of buckling behavior, including critical buckling load and modes of failure of thin laminated composites with different stacking sequences. A semi-analytical Rayleigh–Ritz approach is first developed to calculate the critical buckling loads of square composite laminates with SFSF (S: simply-support, F: free) boundary conditions. Then, these laminates are simulated under axially compression loading using the commercial finite element software, ABAQUS. Critical buckling loads and failure modes are predicted by both eigenvalue linear and nonlinear analysis.

Xiao-Ping Shu, Kostas P. Soldatosdeveloped a 3D-FE model of delaminated fiber reinforced composite plates to analyse their dynamics. Natural frequencies and modal displacements are calculated for various case studies for different dimensions and delamination characteristics. Numerical results showed a good agreement with available experimental data. A new proposed model shows enhancement of the accuracy of the results.

METHODOLOGY

The limited component technique is a generally utilized and integral asset for dissecting complex structures. Numerous specialists have demonstrated the piezoelectric activation utilizing the limited component strategy. The industrially accessible limited component programming ANSYS can investigate piezoelectric materials. In this examination, ANSYS is embraced to research the consonant vibration of an essentially upheld composite plate energized by the surface reinforced piezoelectric actuators.

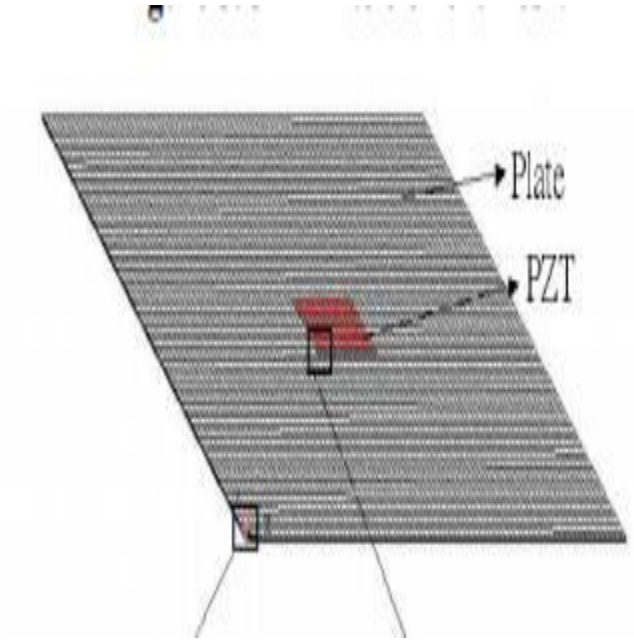

Figure the model of composite plate

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Parametric Study and Verification

Methodology flow chart

Study about the composite plates

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Design consideration of composite plate for piezoelectric materials

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Study on properties of piezoelectric materials used in preparation of heat sensors

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Selection of materials for testing and design in software

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Theoretical and numerical analysis of piezoelectric materials

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Thermal properties consideration and preparation of simulations by using ANSYS 15.0 work bench

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Comparisons of theoretical and analyzed calculations

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Conclusions & Future scope

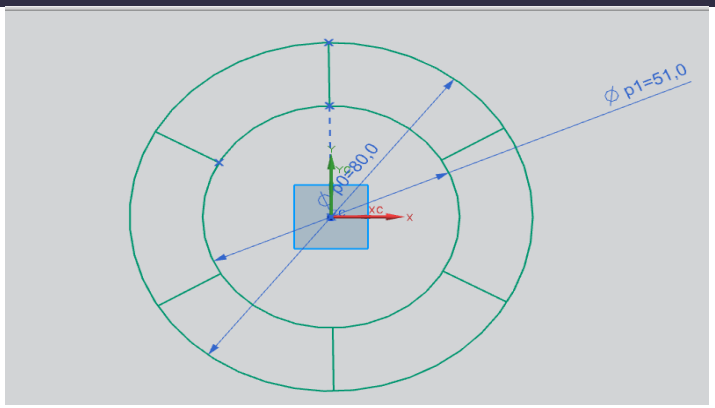

Figure shows the 2d-sketch and dimension of laminated composite plate

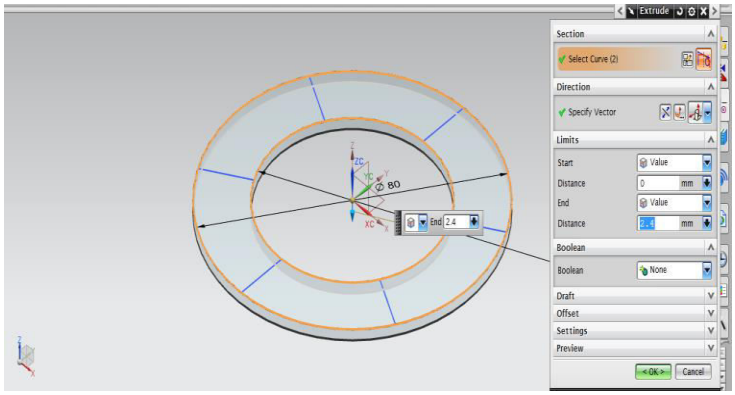

Figure shows the 3d extrude of base component of laminated composite plate

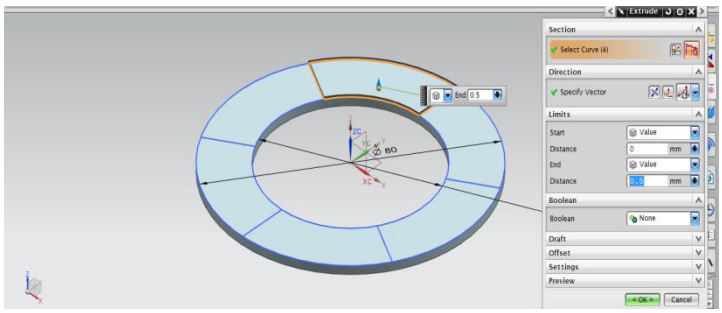

Figure shows the 3d extrude of layer component on the surface of laminated composite plate

RESULTS

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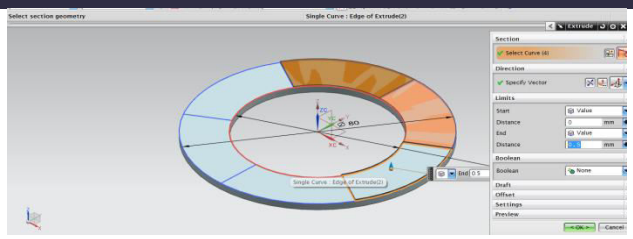

Figure shows the 3d extrude of base component on the surface of laminated composite plate

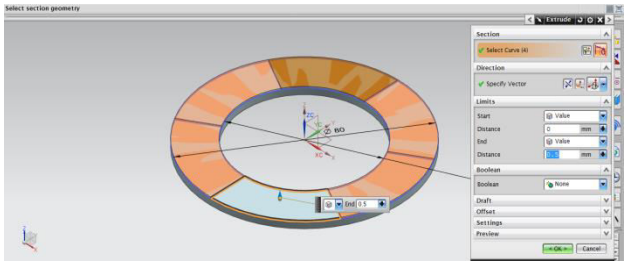

Figure shows the layer assembly on the surface of laminated composite plate

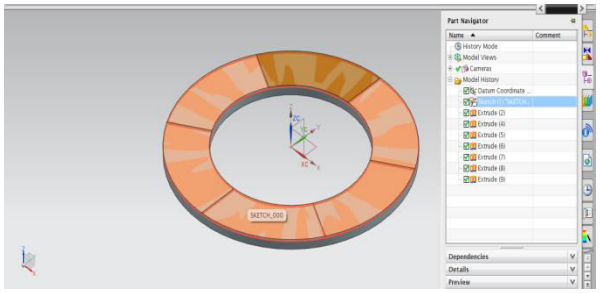

Figure shows the model tree of stator component with 0.5 layer of laminated composite plate

CONCLUSION

Finite element analysis of cross ply laminated composite square plate is carried out, using a 8 – noded isoparametric quadratic element to predict the transverse displacements , normal stresses and transverse shear stresses, when it is subjected to transverse loading under simply supported boundary conditions. The present model is developed based on the First order Shear Deformation Theory (FSDT). This theory uses a shear correction factor to approximate the transverse shear stresses. A computer program is written in MATLAB to get various results. The accuracy of results obtained using the present formulation is demonstrated by comparing the results with three-dimensional elasticity solution ,closed form solutions of FSDT and Classical Laminated Plate Theory.

The present analysis gives accurate values for displacements and stresses compared to Classical Laminated Plate Theory. It is observed that the results are in close agreement with closed form solutions of FSDT and 3-D elasticity solutions. It is found that, the transverse shear stresses vary constantly through the thickness. This is attributed to the use of shear correction factor in the theory. But, the actual variation of the transverse shear stresses is parabolic according to 3D elasticity using equilibrium relations in predicting the same. Moreover, the results of stresses are calculated at Gauss points and they are expected to differ from the analytical solutions. Adoption of reduced integration scheme alleviated the shear locking effects. The present model accurately predicts the transverse displacements and various stresses for thin as well as thick laminated composite plates.

As the present model is developed using a non-conforming element, the results can be further improved using a conforming element with improved mesh size thereby increased no of elements. Infact, the FEM

results approach the true solutions, with the increase in the number of elements.

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