Simulation of Modal Responses of L-bonded Layered Structure

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ABSTRACT: The composite structural members are broadly used in the following application such as aerospace, automobiles, robotics arms, architecture etc. In such application and also for joining various composite parts together they are fastened together either using adhesives or mechanical fasteners. An numerical and simulation of the behavior of composite L-joints under higher-rate dynamic load is presented including the investigation of different joint designs to increase damage tolerance and failure resistance. Modeling of static analysis of 3D model and manufacturing of the composite joints, were carried out using ANSYS APDL software. The result was interpreted in term of von-misses stress. A numerical modal analysis was under taken for models of L-shape structure and it was shown that the mode shapes. We compared the theoretical natural frequencies. The present study include the effect of transverse shear deformation and can be easily used to compute the natural frequencies and mode shapes of delaminating plates with arbitrary boundary conditions. The presence of local modes in the delaminated segment is also discussed.

KEYWORDS: ANSYS, APDL, transverse shear deformation, natural frequencies

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1 INTRODUCTION

Composite materilas are structural materials which are obtained by combination of two or more different constituents on a micro scopic scale. L-Shaped performed non-linear modal analysis considering only in-plane motions. Vibrations of an L-Shaped beam structure considering only in-plane bending non-linear motions. In 1996 they studied the formulation of models of layered composite, considering delaminations effects using interfacial constructive laws and delamination growth. The one dimensional theory was derived and a finite element model was given for the stress analysis of laminated curved composite beams, considering moderate large rotations, moderate large shear strains and different elastic behavior of material in tension and in compression.composite materials which are obtained by combination of two or more different constituents on a microscopic scale.the composite materials inherit the superior qualities of the combining materials such as excellent high strength, good thermal conductivity and low specific density.

A finite element approximation of the theory was also carried out and several numerical applications were developed with reference to lateral buckling of the thin-walled members.

In this article we consider euler-Bernoulli beams made by isotropic material and we derive the first order approximation, the linear equations of motion for an L-Saped beam considering also rotary inertia effects. Examination of the equations of motion indicates that in-plane bending and other motions are well separated at the absence of rotary inertia when considering the out-of-plane bending. We perform, numerically, linrear modal analysis of two models for the L-Shaped beam structures and we confirm that the modes are well separated in the two kinds of motion in-plane and out-of-plane. Also we examination of the mode shapes corresponding to torsional motion of the secondary beam.

This work is essential in order to perform accurate linear modal analysis of an L-Shaped beam, and for the development in the near future of a new non-linear model of an L-Shape beam structures.

In this numerical technique the vibration analysis of continuous plates having orthogonal straight edges by using a set of two-dimensional orthogonal plate functions suggested recently. The method has been applied successfully to analyze plate vibration with mixed edges boundary conditions. It is further extended here to analyze several rectangular L-Shaped plate systems continuous over rigid line supports having various combinations of edge boundary conditions. This is done by approximate modification of the admissible starting plate function.

2 OBJECTIVE OF THE WORK

The aim of the current study is to characterize the failure behavior of such composite L-bonded layered structured simulation Equivalent (Von-Misses), maximum principal stress, pressure intensity etc. This study is also necessary in order to avoid resonace of large structure under dynamic loading. The mode shapes for different boundary condition are to be obtained using ANSYS 16.0.

3 MODEL PREPARATION AND SIMULATION

3.1 Model preparation using ANSYS

ANSYS a finite element software is being generally used byengineer worldwide.ANSYS can be employed in vitually all the field of engineering such as structural,thermal and mechanics etc.In this present work ANSYS 16.0 is used to model L-Bonded layer structure, to calculate natural frequency and vibration analysis.The element type SOLID 20 node 186 is

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used which has 20 node and suitable for L-Bonded layered structure.The boundary conditions are C-C-C-C and F-F-F-F.The present study can be easily used compute natural frequencies and node shapes with arbitrary boundary condition.

3.2 Terminology

SOLID 20 node 186 is an element type for solid structure.this element has twenty nodes and the structure is assumed to be linear elastic and orthotropic. The geometry, nodes and coordinate system of a solid element is shown in Fig.1.

3.3 Advantages of bonded structures

Bonded joints can be made by gluing together pre-cured laminates with the suitable adhesive or by forming joints during the manufactureing process, in which case the joint and laminate are cured at the same time (co-cured). Here, load transfer between the substrates takes place through a distribution of shear stress in the adhesive. Following are some advantages of bonded structure;

1. Large bonded area for load transfer
2. Low stress concentration
3. Smooth external surface at the joint
4. Less sensitivity to cyclic loading, time and cost saving, high strength to weigth ratio, electrical and thermal insulation
5. Conductivity, corrosion and fatigue resistance, crack retardation, damping character

3.4 Modal analysis

Modal analysis is done to determine the vibration characteristics (natural frequencies and mode shapes) of a structure or a machine component while it is being designed. Modal analysis in the ANSYS family of product is a linear analysis. Any nonlinearities, such as plasticity and contact (gap) element, are ignored even if they are defined. You can choose several mode extraction methods: subspace, Block Lanczos, Powerdynamics, reduced, unsymmetric, and damped.

4 OVERVIEW OF STEPS IN MODAL ANALYSIS

The procedure for a modal analysis consists of four main steps:

1. Build the model
2. Apply loads and obtain the solution
3. Expand the modes
4. Review the results

4.1 Build the model

Specify the job name and analysis type and then use SOLID 20 node 186 to define element types, element real constants, material properties and the model geometry.

4.2 Apply loads and obtain the solution

Define the analysis type and option, apply load step options, and begin the finite element solution for the natural frequencies.

4.3 Expand the modes

In a modal analysis, however we use the term ëxpansion to mean writing mode shapes to the result file. That is expanding the modes applies not just to reduced mode extraction method, but to full mode shapes from the other mode extraction method as well.

4.4 Review the result

Result form a modal analysis (that is the expansion pass) is written to the structural result file. Result consist of

- Natural frequencies
- Expanded mode shapes
- Relative stress and force distribution (if reqquired)

5 RESULT AND DISCUSSION

5.1 Determination of material properties

The young's modulus in longitudinal direction of the composite plate were determined. The transverse young's modulus in case of L-bonded layered structure is equal to that obtained in longitudinal direction. The shear modulus is obtained using the following equation, for determination of poission's ratio (υ_{12}) and the shear modulus (G_{12}) was also determined.

5.2 Boundary conditions

Numerical results are presented for L-shape layered structure with combination of different boundary conditions. Further description of boundary conditions is as follows:

1. Simply supported boundary
   $V=W=\theta_Y=0$ at $X=0$, a and $U=W=\theta_X=0$ at $Y=0$, b

5.3Modal analysis

It consists of defining element type, material properties, sectioning, modelling and meshing. The L-bonded layered structure is modelled and meshing using ANSYS which are shown in Fig. 1 and Fig. 2 respectively.

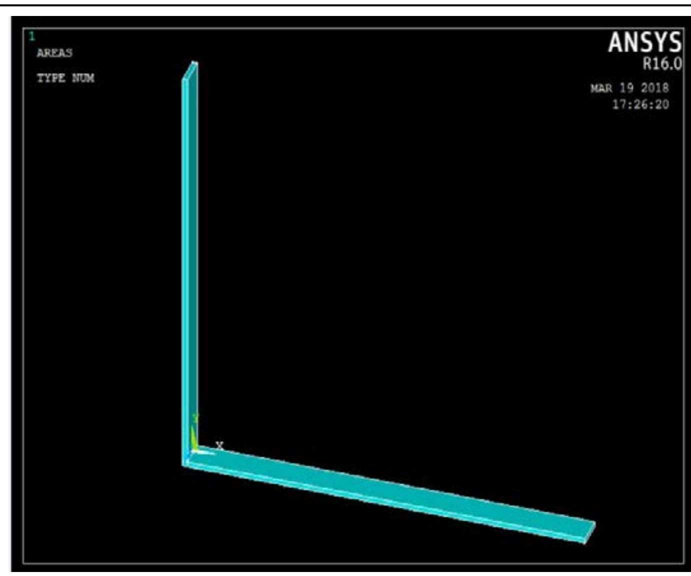

Fig. 1. L-bonded layered structure modelled in ANSYS

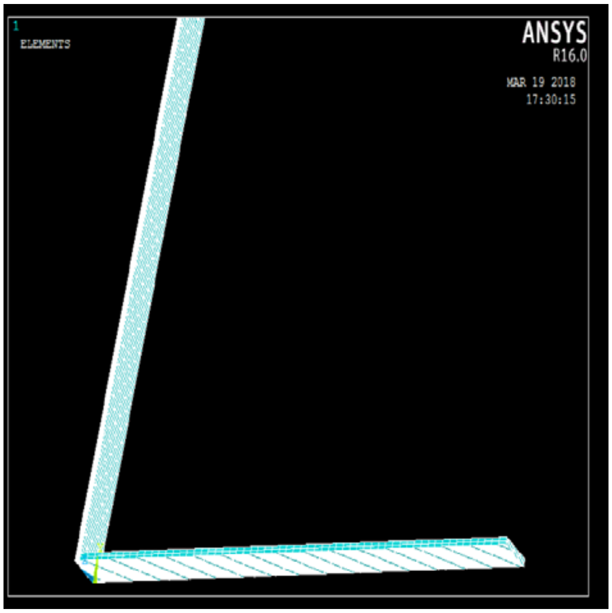

Fig. 2. Meshing of L-bonded layered structure

Fig.3. shows that loads are applied over the area of model and displacement takes place as per the boundary conditions. Where all DOF are zero.

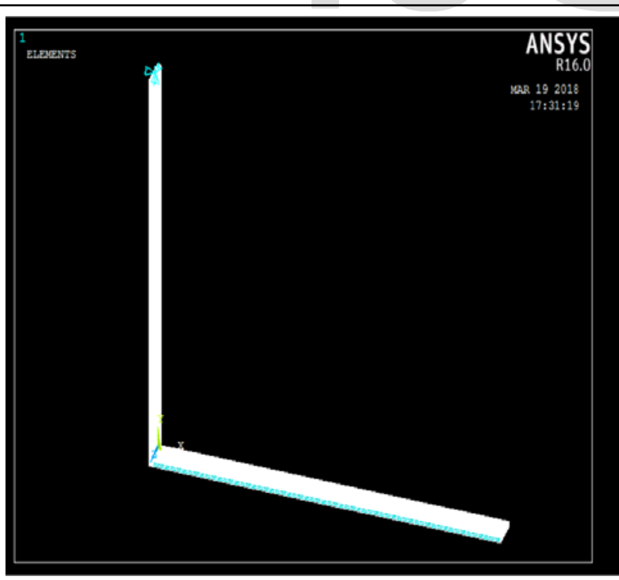

Fig.3. Loading and Boundary condition of L-bonded layered structure

In an elastic body that is subjected to Vonmises stresses and 3-D stresses developed i.e at any point within the body there are stresses acting in different direction and magnitude of stresses changes point to point are shown in Fig.4.

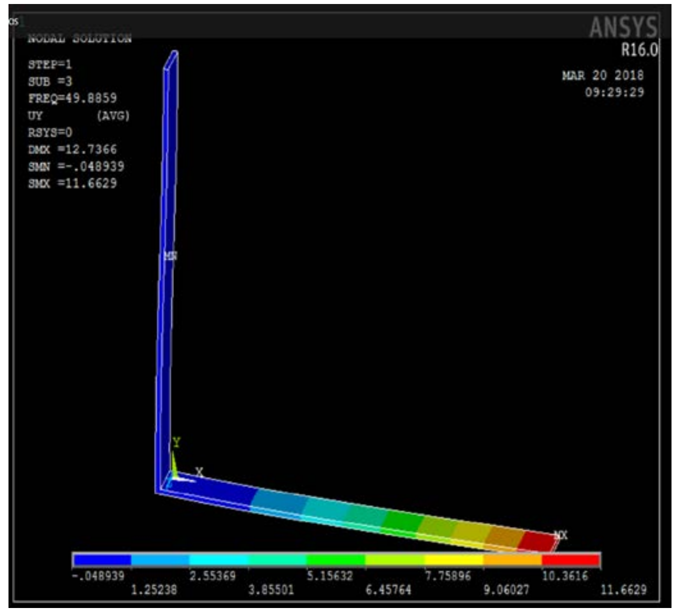

Fig. 4. Vonmises stress of L-bonded layered structure

5.4 Comparision with previous result

TABLE 1
Comparision of Natural Frequencies (HZ)

Mode no	Freq. (F.Georgiades etal.)(HZ)	Freq. Present ANSYS (HZ)
1	16.0	18.23
2	56.9	59.89
3	372.8	379.3
4	944.9	951.6
5	1088.3	1094.2
6	1928.6	1935.8
7	3070.7	3082.5
8	3333.9	3354.4
9	4714.6	4718.3
10	5961.6	5998.1

6 CONCLUSION

The present work deals with the study of modal anlaysis of an orthotropic, elastic L-banded structure having LXbXh = 0.18m X 0.00216m X 0.01295m under free vibration has been done by using ANSYS. Material propertoes of the simply supported structure are young's modulus is 70 Gpa, poisson's ratio is 0.3 and density as 2800 kg/m^3. Natural frequencies of the L-bonded layer structure with varying boundary condition and frequencies.

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