A Survey on - Analysis of Cracked Structure with Finite Element Method (Ansys 15.0)

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Abstract— The free vibration analysis of the cracked beam with many flexible cracks using using Finite Element Method (FEM) in the ANSYS 15.0. In this study, the matrix used for standard deviation. As most of the structures fail near the natural calamities. It is important to establish a mechanism for these structures to obtain the above claims using experimental and quantitative analysis to determine the natural quantity of hybrid composite plates. Test values established Modal Test using FFT Analyzer. The results were compared against the Package of Element (ANSYS 15.0). It has been observed that wind waves decrease with increasing cracking rates; an increase in the number of layers and values differing in the changing positions of the cracks. The reflection frequency is higher when the crack is in the center of the plate or when the angle of oriental is 90 degrees directly in the center of the plate.

Keywords: FEM, ANSYS 15.0, Modal hammer, Accelerometer, FFT Analyzer, Pulse software, Instron, Tensile Strength

I. INTRODUCTION

Hybrid composites are formed by the incorporation of different types of fibers into a specific matrix. The properties of these alloys are the sum of the properties of its individual components. The main advantage of hybrid composites is that the defects of one fiber are balanced by other advantages; The result is an optimal balance between economy and performance. Some of the advantages of hybrid alloys over conventional alloys are higher strength to weight ratio, reduced cost and better resistance to fatigue and impact loads. High strength to weight ratio, low chance of brittle cracking, corrosion resistance, high impact strength, high modulus of elasticity, dimensional stability, low thermal conductivity and lack of warping phenomenon make it a good alternative to steel and other alloys.

A. Research Significance

In order to assist in a consistent safety evaluation of a structure, it is essential to regularly review the health of its critical components. It requires a continuous evaluation of changes in their dynamic behavior. Cracks initiate a change in structure by local reduction of the structural strength. The presence of a crack is a warning to carefully check the behavior of the structure, which will prevent that part from being used completely. Such observation plays a major role in providing continuous operation in service by component. It is very important to monitor defective parts such as cracks or cracks in the service based on vibration and vibration of parts with cracks has been extensively studied.

II. OBJECTIVES

The main objective is to study and compare the numerical and experimental results of free vibration Structure with Finite Element Method with the use of ANSYS 15.0

The present study is aimed to analyse the dynamic behaviour of hybrid composites (glass + carbon fiber) by introducing the finite element package ANSYS15.0 along with experimental methods. Experimental work in the Structural lab was carried out to determine the natural frequency under different variable conditions. The outcomes of these experiments were compared with the analytical values from FEM package.

III. RESEARCH SIGNIFICANCE

The literature is thoroughly examined in order to gain an in-depth knowledge of the subject and to shed light on the importance of the present study. Very few papers have associated experimental methods for understanding the behavior of natural frequency of plates. Few research papers have made use of analytical software's like ANSYS 15.0 in their studies, thus providing scope for ample research.

1) *[Guohui et.al]* studied the free vibration of beams with multiple phase modifications by discrete singular convolution (DSC). It can be observed that the DSC results are more accurate than the data obtained by the differential quadrature element method for very high mode frequencies.
2) *[Savedra and Quitino]* provided an experimental and theoretical dynamic response for various multi-beam systems with inverted cracks. Additional flexibility is estimated using the strain energy density function given by the linear fracture mechanics theory.
3) *[Jaworski and Dowell]* using Rayleigh Ritz formulation, Component modal analysis and Finite Element Method(FEM) results obtained from ANSYS to predict the three lowest natural frequencies of multiple-stepped beam. The confirmation of the results is done with the experimental results from impact testing data.
4) *[Naik and Ramasimha]* studied the impact response and damage tolerance properties of glass carbon hybrid composite plates. Instrumented drop weight impact test apparatus was used to execute experimental analysis.
5) *[Avci and Sahin]* applied first order shear deformation theory for the analysis of symmetric and antisymmetric cross-ply laminated hybrid composite plates with an inclined crack subjected to thermal loading. The eight-noded theory was used for deriving the thermal buckling temperatures of laminated hybrid composite plates.
6) *[Senyer and Kazanci]* investigated nonlinear dynamic responses of a laminated hybrid composite plate subjected to time-dependent pulses using Galerkin's

method and a ANSYS 15.0 software code written to solve nonlinear coupled equations by using this Method.

7) *[Abeysinghe et al.]* investigated the dynamic behavior of Hybrid Composite Floor Plate System using experimental and numerical analysis (FE modelling). Investigations were conducted by applying the FE model to understand the dynamic nature of the hybrid plate system and to classify characteristics that affect acceleration of structure under service loads.

IV. PHYSICAL PARAMETERS

Usually the physical dimensions, boundary conditions, the material properties of the structure play important role for Determination of its dynamic response. Their vibrations cause changes in the dynamic properties of the structures. Cracks in the structures modified its dynamic behavior in addition to this presence. The following elements of the crack greatly influence the dynamic response of the structure.

- The position of the crack
- Depth of crack
- Orientation of the crack
- Number of cracks

V. CLASSIFICATION OF CRACKS

Based on their geometry, cracks can be broadly classified as follows:

- Cracks perpendicular to the beam axis are called "inverted cracks". These are very common and severe as they reduce the cross section and thereby weaken the beam. They introduce local flexibility in the stiffness of the beam due to the energy density near the crack tip.
- Cracks parallel to the Beam axis are called "longitudinal cracks". They are not so common that when a tensile load is applied they are at a right angle to the crack direction, i.e. perpendicular to the beam axis or perpendicular to the crack.
- “Slant cracks” (cracks at an angle to the beam axis) can also occur, but are not very common. These affect the bending behaviour of the beam. Their effect on lateral vibrations is less than that of transverse fractures of comparable intensity.

VI. MATERIALS REQUIRED FOR FABRICATION

- Carbon and Glass fiber (reinforcement)
- Epoxy (resin)
- Hardener (generally 8-10% x quantity of epoxy)
- Polyvinyl Alcohol (PVA) (releasing spray)

VII. METHODOLOGY & EQUIPMENTS REQUIRED

Mixed samples were transmitted using the hand-layup method. Matrix element epoxy was applied along with carbon and glass fiber. The ratio of fiber and matrix was taken in the ratio of weight 1: 1 where the matrix components contain resin and hardeners. The calculation of epoxy and hardening sizes is shown in the table below. After placing each layer, the matrix is applied uniformly on top of each layer. Any air in the vacuum was removed using steel rollers. The heavy weight was placed on the top board and the samples were kept at room temperature for at least 48 hours. They were then cut to exact dimensions of 235x235 mm and taken for tensile testing.

- Modal hammer
- Accelerometer
- FFT Analyser
- Pulse software

1) Modal Hammer: The initation of Modal testing was done by exciting the specimen with the help of a modal hammer (Model No. - 2302-5). As a consequence of this, the Plate vibrated at its ‘natural frequency’.

2) Accelerometer :(B&K Type 4507) Accelerometer is the equipment connected to sensor i.e. it senses the frequency of vibration of the plate and conveys it to FFT analyser.

3) FFT Analyzer: FFT analyser receives the signal from Accelerometer and is the primary device of this vibration setup. The signal is transferred to the computer which displays the Frequency Response Function (FRF) through the pulse software.

4) Notebook with PULSE software: This is the display unit which shows the FRF and coherence graph after the input data is analyzed. The peaks of FRF are the natural frequencies of the specimen.

VIII. Discussion

The present study is aimed to analyse the dynamic behaviour of hybrid composites (glass + carbon fiber) by introducing the finite element package ANSYS along with experimental methods. Experimental work in the Structural lab was carried out to determine the natural frequency under different variable conditions. The outcomes of these experiments were compared with the analytical values from FEM package.

The study intends to incorporate the following tests to get an accurate analysis for the vibrational characteristics of cracked plates involving a wide a range of parameters.

1) Young's Modulus and other material constants were calculated using tensile testing.
2) Modal testing using ANSYS The factors which are varied include:
   1) Length, depth, orientation, position and mode of propagation of crack
   2) Support conditions
   3) Thickness of plate.

FEM software ANSYS was used to observe the variation of these factors on the natural frequencies.

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