"A WORK PAPER ON - ANALYSIS OF CRACKED STRUCTURE WITH FINITE ELEMENT METHOD (ANSYS 15.0)"

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Abstract

The research reveals the free vibration of the uniform and embroidered uniform under one of the many cracks using Finite Element Method (FEM) in place of ANSYS 15.0. Specific cracks are the most open cracks in the environment. Due to the presence of a crash, a complete flexible matrix is established by adding an additional variable matrix to the flexible matrix of the corresponding coastal element .The local variable matrix is located in the Linear Elastic Fracture Mechanics line. An experimental study was conducted to determine the accuracy of the numerical results. The metal types of the square cross section considered for that test and the test results are compared with the price analysis using Finite Element Method (FEM) in the ANSYS 15.0. The results obtained in the test are accurately assessed and analyzed by setting unlimited breaks of the first three methods as a function of measuring the depth of the various cracks.

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

I. INTRODUCTION

It has been observed that many of the structural members fail due to the presence of cracks. Fractures mainly develop due to fatigue loading. Therefore identifying cracks is an important aspect in architectural design. Fractures that occur in a structural element cause some local variation in its appearance, which significantly affects the dynamic behavior of the element and the overall structure. The frequencies of natural vibrations, the amplitude of the forced vibration, and the regions of dynamic stability change as such cracks occur. Analysis of these changes makes it possible to determine the size and location of the cracks. This information allows one to determine the level of stability of the structural element and the overall structure. In this study, the presence of transverse and open crack in the structure was considered. Crack depth also introduces new boundary conditions for construction in this crack area.

II. 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.

[Lee and Kim] experimented on non-linear vibrational analysis of hybrid composite panels using the various equation. The effect of stacking sequences, different aspect ratios, number of modes, number of layers and elastic properties on nonlinear vibration behavior was investigated. The results were compared with the ABAQUS & FEM analysis. Multi-level FEM analysis of laminated composites was studied with lamination cracks as a result of transverse cracking.

[Hardai et al.]] Studied the consistent behavior of composite plates with small cracks under supported conditions only using the Ritz method. A second local analysis was used in which a small area covering the proximity of the crack and other single points was separated using a finite element mesh.

[Ng Kong et.al] describes a crack identification method that combines violet analysis with the Transform Matrix used for crack detection in complex construction. The peaks of the violet modules give the crack location. The first two natural frequencies are used to determine crack position and crack depth. Frequency data and mode are obtained from the model analysis in the ANSYS code.

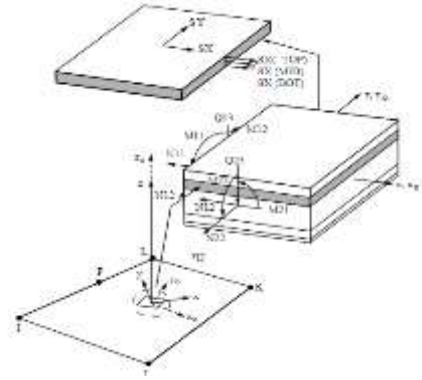
[Amene et.al] discussed the simplest way to detect, localize, and quantify cracks formed in Euler-Bernoulli multi-stepped beams, by occurring naturally occurring by measuring the frequencies and by estimating incomplete mode patterns. Not only is the procedure simple, it also has the advantage of detecting an unknown number of cracks.

[Kar and Nutt] experimented on bending and fatigue properties of hybrid composite rods. The rods were made of a combination of glass an carbon fiber. Examination was done a macroscopic level to identify failure propagation. Weibull theory was applied to evaluate the probability of damage.

[Hong et al.] focussed on the damping behaviour of composite blade using principle of Rayleigh damping. The damping test was carried out to validate the hybrid method. The influence of orientation of fiber and order of stacking on the damping studies were studied.

III. ELEMENT SETUP

Shell 281 Element has 8 nodes with 6 degrees of freedom at each node. This element is used is linear and non-linear structural as well as acoustic analysis. The theory is influenced by shear deformation theory of first order.



$A(X, Y, M) = A_0(X, Y) + M\Theta_X(X, Y)$

$B(X, Y, M) = B_0(X, Y) + M\Theta_X(X, Y)$

$C(X, Y, M) = C_0(X, Y) + M\Theta_X(X, Y)$

The strain vector in terms of displacement vector is as follows:

$\{ e\} = [B] \{\partial\}$

Weight of glass fibers + carbon fibers (4 layers each): 193g
Wt. of matrix (epoxy + hardener) = 193 g
Wt. of hardener = 8% x quantity of epoxy
Let E= wt. of epoxy, H= wt. of hardener.

H =0.08 x E

- E + H = 193

➢ E + 0.08 x E = 193

➢ E = 193/1.08

➢ E = 178.7 g H = 193-178.7 = 14.3 g

Wt. of Epoxy =178.7 g
Wt. of hardener=14.3 g

Figure: Hand Lay-Up Technique

Table: Material properties of the fabricated sample plate

Sl. No.	No. of layers of fibers	Length of plate(m)	Width of plate(m)	Thickness of plate(m)	Mass of plate (in gram)	Density of plate (kg/m^3)
1	8	0.235	0.235	0.003	193	1291.69

Instron Setup

Tensile Testing RESULTS

IV. RESULTS OF MODAL ANALYSIS

Table: Variation of Natural Frequencies for Cracked and Uncracked Plate in FFFF condition

l= length of crack, d= depth of crack, L=length of Plate=235mm

Mode	Experimental Results (uncracked) in Hz l=0.1 L=23.5mm, d=1mm	Experimental Results (cracked) in Hz	Ansys Results (uncracked) in Hz	Ansys Results (cracked) in Hz
1	376	364	412.31	411.38
2	508	492	564.57	561.19
3	596	584	624.86	621.71

Table: Variation of Natural Frequencies for Cracked and Uncracked Plate in CFFF condition

l= length of crack, d= depth of crack, L=length of Plate=235mm

Mode	Experimental Results (uncracked) in Hz l=0.1L=23.5mm,d=1mm	Experimental Results (cracked) in Hz	Ansys Results (uncracked) in Hz	Ansys Results (cracked) in Hz
1	160	152	164.76	163.68
2	196	184	209.29	207.36
3	224	216	240.51	237.57

Table: Variation of Natural Frequencies for Cracked and Uncracked Plate in SFSF condition

l= length of crack, d= depth of crack, L=length of Plate=235mm

Mode	Experimental Results (uncracked) in Hz l=0.1L=23.5mm, d=1mm	Experimental Results (cracked) in Hz	Ansys Results (uncracked) in Hz	Ansys Results (cracked) in Hz
1	252	248	283.49	281.17
2	296	276	299.52	297.78
3	312	304	361.46	356.88

Table: Variation of Natural Frequencies for Cracked and Uncracked Plate in CFCF condition

l= length of crack, d= depth of crack, L=length of Plate=235mm

Mode	Experimental Results (uncracked) in Hz l=0.1L=23.5mm, d=1mm	Experimental Results (cracked) in Hz	Ansys Results (uncracked) in Hz	Ansys Results (cracked) in Hz
1	316	308	336.18	333.85
2	432	412	469.78	469.22
3	496	476	517.63	514.76

Effect of varying the depth of the crack

Table: Variation of Natural Frequencies for Cracked and Uncracked Plate in FFFF condition

l= length of crack, d= depth of crack, L=length of Plate=235mm

Mode	Experimental Results (uncracked) in Hz l=0.1L=23.5mm, d=1mm	Experimental Results (cracked) in Hz l=23.5mm, d=2mm	Ansys Results (uncracked) in Hz l=23.5mm, d=1mm	Ansys Results (cracked) in Hz l=23.5mm, d=1mm Hz
1	364	364	411.38	409.69
2	492	488	561.19	560.32
3	584	576	621.71	619.19

Table: Variation of Natural Frequencies for Cracked and Uncracked Plate in CFFF condition

l= length of crack, d= depth of crack, L=length of Plate=235mm

Mode	Experimental Results (uncracked) in Hz l=0.1L=23.5mm, d=1mm	Experimental Results (cracked) in Hz l=23.5mm, d=2mm	Ansys Results (uncracked) in Hz l=23.5mm, d=1mm	Ansys Results (cracked) in Hz l=23.5mm, d=1mm Hz
1	152	136	163.68	163.52
2	184	180	207.36	207.33
3	216	204	237.57	235.51

Table: Variation of Natural Frequencies for Cracked and Uncracked Plate in SFSF condition

l= length of crack, d= depth of crack, L=length of Plate=235mm

Mode	Experimental Results (uncracked) in Hz l=0.1L=23.5mm, d=1mm	Experimental Results (cracked) in Hz l=23.5mm, d=2mm	Ansys Results (uncracked) in Hz l=23.5mm, d=1mm	Ansys Results (cracked) in Hz l=23.5mm, d=1mm
1	248	228	281.17	281.09
2	276	272	297.78	297.71
3	304	300	256.88	356.23

Table: Variation of Natural Frequencies for Cracked and Uncracked Plate in CFCF condition

l= length of crack, d= depth of crack, L=length of Plate=235mm

Mode	Experimental Results (uncracked) in Hz l=0.1L=23.5mm, d=1mm	Experimental Results (cracked) in Hz l=23.5mm, d=2mm	Ansys Results (uncracked) in Hz l=23.5mm, d=1mm	Ansys Results (cracked) in Hz l=23.5mm, d=1mm
1	308	304	333.85	332.96
2	412	400	469.22	468.27
3	476	460	514.76	512.71

Effect of varying the Length of the crack

Table: Variation of Natural Frequencies for Cracked and Uncracked Plate in FFFF condition

l= length of crack, d= depth of crack, L=length of Plate=235mm

Mode	Experimental Results (uncracked) in Hz l=0.2L=47mm, d=1mm	Experimental Results (cracked) in Hz l=141mm, d=1mm	Ansys Results (uncracked) in Hz l=47mm, d=1mm	Ansys Results (cracked) in Hz l=141mm, d=1mm
1	360	336	410.88	406.18
2	488	476	560.74	558.85
3	578	554	621.11	612.55

Effect of varying the number of layers

Table: Variation of Natural Frequencies for Cracked and Uncracked Plate in FFFF condition

l= length of crack, d= depth of crack, L=length of Plate=235mm

Mode	Experimental Results (uncracked) in Hz l=0.1L=23.5mm, d=1mm, 8 layers	Experimental Results(cracked) in Hz l=23.5mm, d=1mm, 4 layers	Ansys Results (uncracked)in Hz, l=23.5mm, d=1mm,8 layers	Ansys Results (cracked) in Hz l=23.5mm, d=1mm, 4 layers
1	364	186	411.38	206.155
2	492	226	561.19	282.38
3	584	286	621.71	312.63

Effect of varying the angle of orientation of crack w.r.t centre of plate

Table: Variation of Natural Frequencies for Cracked and Uncracked Plate in FFFF condition

l= length of crack, d= depth of crack, L=length of Plate=235mm

Mode	Experimental Results (uncracked) in Hz l=0.1L=23.5mm, d=1mm, 45 degree	Experimental Results (cracked) in Hz l=23.5mm, d=1mm, 30 degree	Ansys Results (uncracked)in Hz, l=23.5mm, d=1mm, 45 degree	Ansys Results (cracked) in Hz l=23.5mm,d=1m, 30degree
1	368	368	411.93	411.18
2	492	472	564.52	562.375
3	584	580	623.19	621.523

Effect of varying the position crack w.r.t centre of plate

l= length of crack, d= depth of crack, L=length of Plate=235mm Crack location-0.2d from centre

Table: Variation of Natural Frequencies for Cracked Plate in all 4 boundary conditions

Mode	Experimental Results (cracked) in Hz, CCFF l=23.5mm, d=1mm,	Experimental Results (cracked) in Hz, SFSF l=23.5mm, d=1mm,	Ansys Results (uncracked)in Hz, CCFF l=23.5mm, d=1mm,	Ansys Results (cracked) in Hz, FFFF, l=23.5mm, d=1mm
1	308	364	163.82	412.78
2	412	492	208.06	561.85
3	476	584	237.92	622.86

V. CONCLUSION

The present study deals with the vibrational behavior of glass-carbon hybrid composite panels measuring 235x235mm using the FFT analyzer. Frequency Response Function (FRF) of composite panels was examined using FFT Analyzer by Pulse Software. Variation in parameters such as length, depth, and tendency of the crack had a significant effect on the natural frequency of these alloys. The results thus obtained were compared with values from the finite element package software ANSYS.

Important conclusions drawn from this research work:

1. As the depth of the crack increases, the natural frequency decreases in the experimental and ANSYS results.

2. Both the experimental and ANSYS values decrease with increasing length of the crack. However the decrease is less compared to the previous case.

3. The virtues of natural frequencies follow the following order. FFFF> CCFF> SS> CFFF

This relationship is good for all cases

VI. SCOPE FOR FUTURE WORK

Current research work can be extended to the following areas:

- Vibrational behavior of hybrid composite tiles with cracks under Hydrothermal Effects.
- Different Buckling behavior of cracked hybrid composite plate under different loading conditions.
- Effect of joints on vibrational studies of hybrid compounds.
- The study of the natural frequencies of delaminated hybrid composites.

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