

Free vibration of natural fiber laminated composite plate with cut-out

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Abstract - The research work is about vibration analysis of woven fabric natural fiber laminated composite plate with cut-out. This present work has been conducted by vibration analysis of natural fiber composite plate namely jute epoxy (J/E), sisal epoxy (S/E) plates with and without cut-out. The present study deals with numerical investigations on vibration analysis of woven fabric natural fiber laminated composite plates with and without cut-out. Numerical analysis is carried out by ANSYS 16 model based on finite element method laminated composite plates with and without cut-outs. The presence of cut-out may change the nature of the vibration of the plates. It is, therefore, vital to examine the vibration of laminated composite plates with cut-out. Also, the effect of different parameters, e.g. boundary condition, hole-size, number of layers etc. need to be examined for a safe and stable design of structures. Different parameters like several layers, various fiber, cut-out size and positions, boundary condition are contemplated in free vibration analysis. Natural frequency on free vibration and mode shape of a laminated composite plate with different boundary conditions such as C-C-C-C, S-S-S-S, C-F-C-F and C-F-F-F in the different layer are conferred. The results from the numerical method show that the natural frequency of a laminated composite plate rises with increasing no. of the layer.

Keywords — *Natural fiber composite plate, Vibration analysis, Cut-out, ANSYS software*

I. INTRODUCTION

Natural fibers are produced from plants, animals, and geological processes. It can be used as a component of composite materials. Natural fibers have many advantages compared to synthetic fibres, for example, low weight, low density, low cost, acceptable specific character, and they are recyclable and biodegradable. Now a day laminate composite plates are preferred in various industrial applications such as racing bikes or vehicles, automotive structural part, swimming pool, aerospace, civil engineering structure. Cut-outs in laminated composite plates are necessary for connecting the components, damage inspection, reach ports, electrical and fuel lines, opening in a structure, provide ventilation and to reduce weight.

Laminated plates with cut-outs are broadly used in automobiles, aircraft, and space crafts. These structures are subjected to inexpedient vibration, deflection and rotation during their service life. Cut-outs of various shapes circular, square, rectangular, elliptical are used in plates and effects the vibration characteristics of the plate. Therefore, vibration analysis of natural fiber laminated

composite plates with cut-out is important to predict the resonance condition.

The current research works focus on the free vibration characteristics of natural fiber laminated composite plates with cut-out. An attempt has been made to search the free vibration characteristics of square laminated composite plates with cut-out and without cut-outs. For the outcrop of the analysis, the plate is supposed to be orthotropic and symmetric to the mid-plane. The impact of boundary conditions, hole-size, and the number of layers on the natural frequencies of vibration are studied. The analysis was conducted numerically by using ANSYS 16 software

Materials used

The woven fabric type natural fiber is used. Two types of natural fiber that is jute and sisal fiber

Jute fiber

Jute is the best fiber used for sacking, burlap, and twice as a backing material for capitated carpet. Jute fiber is 100% bio-degradable and recyclable and thus eco-friendly. It is a natural fiber with golden and silky shine and thus called

The Golden Fiber. It is an uncostly vegetable fiber procured from the bast or skin of the plant's stem.

Advantages of jute fibre

- More specific modulus as compared to glass fiber
- Great antistatic properties
- Low thermal conductivity
- More tensile strength
- Good insulating properties

Sisal fiber

Sisal fiber is one of the most widely consumed natural fiber and is very easily cultivated. It is achieved from the sisal plant. The plant is known formally as *Agave sisalana*

Advantages of sisal fiber

- Less maintenance with least wear and tear
- ecological
- Good sound and impact absorber
- Well resistance against moist & heat
- Good tension resistance

II. ANSYS MODELLING OF THE PLATE STRUCTURE

Finite element modelling has developed as a very powerful tool in solving many real-life engineering problems. FEM nowadays is used in computing all types of elastic-plastic, residual, thermal, electromagnetic, buckling and thermal analysis. The main objective of finite element modelling is to represent the behaviour of physical structure being analysed. However, it is the modelling techniques and assumptions used in analysis which decide the cleanness of results. ANSYS is a FEM program that is used here to analyse the vibration properties of the plates. ANSYS (an acronym for Analysis System) is a general reason Finite Element Analysis (FEA) program that solves a vast area of solid and structural mechanics problems in geometrically complicated regions. In the present work, ANSYS 16.0 is applied to model the plate, to compute natural frequencies and to plot deformed shapes. In this part, numerical analysis of different natural composite plate is evaluated by using the finite element software ANSYS 16 model as shown in Fig. All laminated plates are modelled in ANSYS with various boundary conditions then analysis done to find out natural frequencies of the different composite laminated plate. The ANSYS modelling solved by (SHELL 8 node 281) with various load application as per different boundary condition.

III. RESULTS AND DISCUSSION

Free vibration analysis of a laminated composite plate with cut-outs is numerically studied by using ANSYS software. The impact of different parameters such as the position of the cut-out, no of layers and cut-out ratio (d/D) under different boundary conditions. Free vibration of the laminated plate with cut-outs are checked up with numerically using ANSYS. Vibration analysis of this study is presented as follows

The vibration behaviour of the composite structures is impressively dominance by laminated plates. So that, in the present investigation natural frequencies of natural fiber laminated composite plates were laid down by numerical method. The effects of various constraints were studied censoriously. The numerical results are compared with other existing literature to create a good agreement for free vibration.

Modal analysis: Modal analysis in ANSYS is a linear analysis. Various mode extraction methods, e.g. Block Lanczos, Supernode, PCG Lanczos, reduced, unsymmetrical, damped, and QR damped are available. Block Lanczos is used in the present analysis. Cut-out may affect the dynamic behaviours of laminated composite structures. Therefore, in this present study, natural frequencies of the composite plate with cut-out are calculated by the numerical programme. The effects of various parameters such as no of layers, the position of the cut-out, different boundary condition on the natural frequency of square cut-out plate were studied. The numerical outcomes of the modal analysis are compared with other existing literature.

IV. CONCLUSION

The present study is related to the effect of the free vibration characteristics on laminated composite plates with cut-outs. The free vibration characteristics of woven fabric natural composite laminated plate i.e.; plain jute/epoxy laminate, plain sisal/epoxy laminate composites are examined in the numerical method. A numerical investigation is determined by ANSYS software respectively. Numerical values are gained for free vibration characteristics of natural fiber laminated composite plates with the effect of different parameters like the effect of the number of layers, fiber orientation, boundary conditions etc. From this analysis, these are the following concluding remarks to be found out during the natural frequency analysis of laminated composite plates.

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