Quest Journals
Journal of Architecture and Civil Engineering
Volume 4 ~ Issue 1 (2019) pp: 82-87
ISSN(Online) : 2321-8193
www.questjournals.org

Research Paper

Effect of Different Layers on the Thermal Stability Analysis of Laminated Composite Panel

Mudukur Swetha
Lecturer, Department of Civil Engineering, Government Polytechnic Mirle, Karnataka, India.

Abstract:
The amount of stress that may be applied to structural materials has significantly increased as a consequence of technological advancements. The increase in permitted stress has enabled the designer to shift from strong materials to lighter and more slender alternatives. This seems to be especially true for newly developed composite materials. A composite material is created by combining two or more components on a macroscopic level to create a useful, strong, and lightweight material. The main benefit of composite materials is that they combine the best qualities of their elements with capabilities that would be impossible for a single component to achieve alone. Lamination-based composites are also often used in a variety of engineering disciplines, such as civil, mechanical, marine, and aerospace engineering. Since their inception, these trapezoidal laminated panels have found extensive use in the aerospace and aviation industries. More recently, they have also been used in civil engineering structures like bridge decks and girders, as well as in the retrofitting and reinforcing of structural members, among other uses.

Keywords: *Layers, Mode Shape, Compressive Load, FEM, Thermal Stability.*

I. Introduction

The application of compressive stresses from the exterior causes composite laminated plates to seem buckled. By combining the properties of two or more materials into a single composite, it is possible to achieve goals that would be difficult to accomplish with just one of the individual components. These materials are the essential building blocks of composites. It is the fibers that bear a disproportionate percentage of the total weight of these materials. A matrix with a low modulus and a high elongation not only offers flexible structural performance but also shields fibers from external pressures and guarantees that they stay in their proper position. Composite materials may significantly reduce a structure's weight without sacrificing its strength-to-weight ratio since they are composed of two or more distinct components. This is due to the fact that composites are made up of several parts. This is due to the fact that composites are composed of several components. In the building sector, laminates—very thin sheets—are often used. This is one of the most common uses for fiber-reinforced composites. One kind of material macrounit that is widely distributed inside the material is called a laminate. It is feasible to alter the orientation of the fibers contained within each lamina and the order in which the layers are layered to give the material the strength and stiffness required for a certain application. A composite material's unique properties are determined by the orientation, distribution, and composition of its constituent elements. These components are in charge of giving the composite material its own set of qualities. Cutouts are essential for a variety of purposes, such as lowering component weight, enhancing air circulation, and connecting nearby components. The composite material known as carbon-fiber reinforced plastic is created by mixing thermosetting resins with a variety of carbon fibers. Carbon fiber reinforced plastic, or CFRP for short, is a kind of polymer that has many advantages, including being lightweight, nonconductive, and reinforced with carbon fiber strands. a component that has an extremely long-lasting impact. Numerous designs, such as stacking a lot of fiber sheets, have the potential to significantly increase the material's strength and stiffness. It is possible to accomplish the intended result by using this strategy. Parth Bhavsar and his colleagues used the finite element method to examine the buckling behavior of glass fiber reinforced polymer (GFRP) under linearly increasing loads.

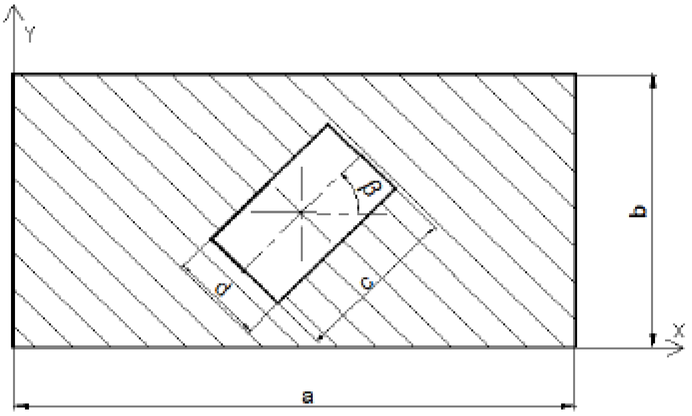

Figure 1: Geometry of the model.

To determine the effect of each of these characteristics on the stress, researchers have examined the buckling Mode shape stress of one-dimensional rectangular plates by examining a variety of factors. The buckling stress (buckling stress) per unit length was calculated by Joshi and his colleagues using two-dimensional finite element analysis after biaxial compression was applied to a rectangular plate with circular incisions. Two approaches that might be utilized to assess the buckling variables include changing the length to thickness ratio and moving the holes. Nagendra Singh Gaira and associates looked at the buckling behavior of laminated rectangular plates. Regretfully, no border clamp was in place throughout the trial. One especially desired result is the decrease in the buckling strain caused by the presence of cuts. The aspect ratio may be increased in order to achieve the goal of reducing the buckling load factor itself. In order to better understand the link between the two, Hamidreza Allahbakhsh and Ali Dadrasi conducted buckling research that concentrated on the effect of an axial load on the buckling load of a laminated composite cylindrical panel. An oval cutout was seen in various sizes and positions over the course of the inquiry. Okutan Baba, a container specialist, focuses on investigating how various cut-out forms, length-to-thickness ratios, and ply orientations affect the buckling stress that rectangular plates experience during production. The researchers used both theoretical and experimental techniques to determine the impact of these parameters on the buckling behavior of the E-glass/epoxy composite plates after applying in-plane compression stress to them. In their study of composite laminate skew plates subjected to uniaxial compressive loads, Hsuan-Teh Hu and his associates found that the failure criteria and nonlinear in-plane shear significantly affected the final loads applied to the plates. This is a highly important issue when compared to the linearized buckling loads, which have a smaller influence.

FINITE ELEMENT MODEL

Straightforward method for adhering to the conference paper's format specifications. The goal of this study is to calculate the buckling load factors of square and cylindrical carbon fiber composite plates using finite element analysis. We are use ANSYS and APDL version 14.5. Three distinct border criteria are used while calculating the plate's dimensions. In these cases, clamped and unclamped states may be distinguished. In the second example, each scenario has three layers, whereas in the first, there are only two. Given that the stacking sequences employed were [0°/+45°/-45°/90°]2s, it is plausible to conclude that this is the case. It is impossible to conduct the research without piercing many identically sized center holes into the plate. The center holes might be square, triangular, round, or star-shaped, among other designs. Research is now being conducted on the characteristics of the buckling load factor. This study applies the finite element method (FEM) to quasi-isotropic graphite/epoxy composite plates with square/rectangular cuts and linearly increasing in-plane compressive loads in order to investigate the buckling response as a function of plate aspect ratio (a/b), length/thickness ratio (a/t), and boundary conditions. Epoxy is used as the matrix material and graphite fibers are used as reinforcements in the construction of the lamina. According to Hsuan Teh Hu and Bor Horng Lin's (1995) study, Table 1 lists the following graphite/epoxy material parameters. The material's x and y axes are exactly perpendicular to the corresponding world axes for this whole period. The plate is subject to pressures that are perpendicular to the global x-axis. Luckily, the 0° fiber and the compressive load go in the same direction.

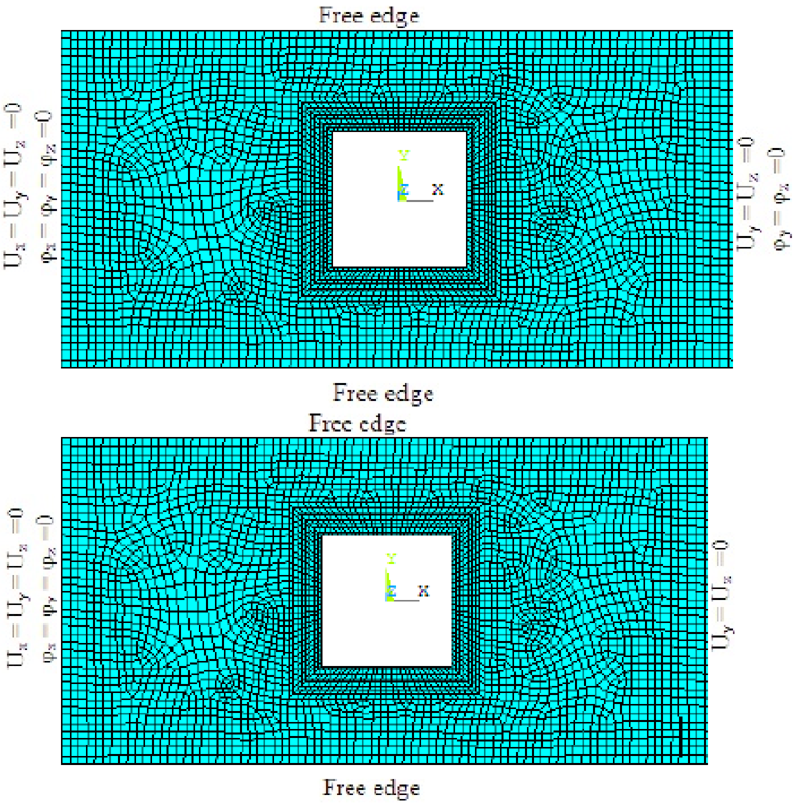

Figure 2: FE model with mesh

DESCRIPTION OF ELEMENT

The SHELL281 element type is used in this investigation. Studying shells of different thicknesses is made feasible by this feature of the shell. Because of its versatility, it's also excellent for simulating sandwich structures and layered composite coverings. The effective use of this material is ideal for applications exhibiting significant strain nonlinearity, linearity, or rotation. The element is composed of eleven nodes, each of which has six degrees of freedom. These degrees of freedom allow the element to be rotated about its three axes and moved along its internal x, y, and z axes. Projects involving the study of cylindrical plates make use of the nonlinear element S8R5. Each of the eight nodes in this element may be freely moved in five different ways. It may be feasible to detect this component if it exists.

GEOMETRIC MODELLING AND MATERIAL PROPERTY

The correspondence between the geometry and the description is clearly seen in Figure 1. Both plate 'b' and plate 'a' have dimensions of 100 millimeters for width and 200 millimeters for length. Each of the sixteen layers that make up this specific laminate is 0.125 millimeters thick. In particular, the symbol "β" stands for the cutout orientation angle's form, and the letter "t" for the plate's thickness. For the sake of this investigation, the cutout orientation angle is thus taken to be zero degrees. The item's foundation is a rectangular plate with a hole carved out in the center, serving as the structure. The factors that comprise the cutout's dimensions are its length (c) and width (d). The rectangular one will serve as the base for the creation of the square hole if the ratios of c and d are equal. Under the identical circumstances as before, the impact of square holes is investigated as an extra topic of interest. Both square and rectangular holes are taken into account during the buckling analysis.

Table 1 : Property of composite material

E_{11} (GPa)	E_{22} (GPa)	v_{12}	$G_{12} = G_{13}$ (GPa)	G_{23} (GPa)
128	11	0.25	4.48	1.53

II. RESULTS AND DISCUSSION

Here, we'll examine the effects of various ply orientations on the plate using the same boundary condition. No lag time will exist between any of these events. This is an illustration of a boundary condition that is currently being discussed. This component uses a variety of ply orientations. The orientations are in the following order, from 0° to 90°, with intervals of [45°/-45°]. If you would like further information, please consult the list that is supplied. To learn what the situation could result in, researchers examine both of them. They are both analyzed, and the ensuing consequences are considered. The figures below show the buckling loads of a rectangular composite plate as a function of the following parameters: rectangular/square cutout, plate aspect ratio (a/b), length/thickness ratio (a/t), boundary conditions, and linearly increasing in-plane compressive stress.

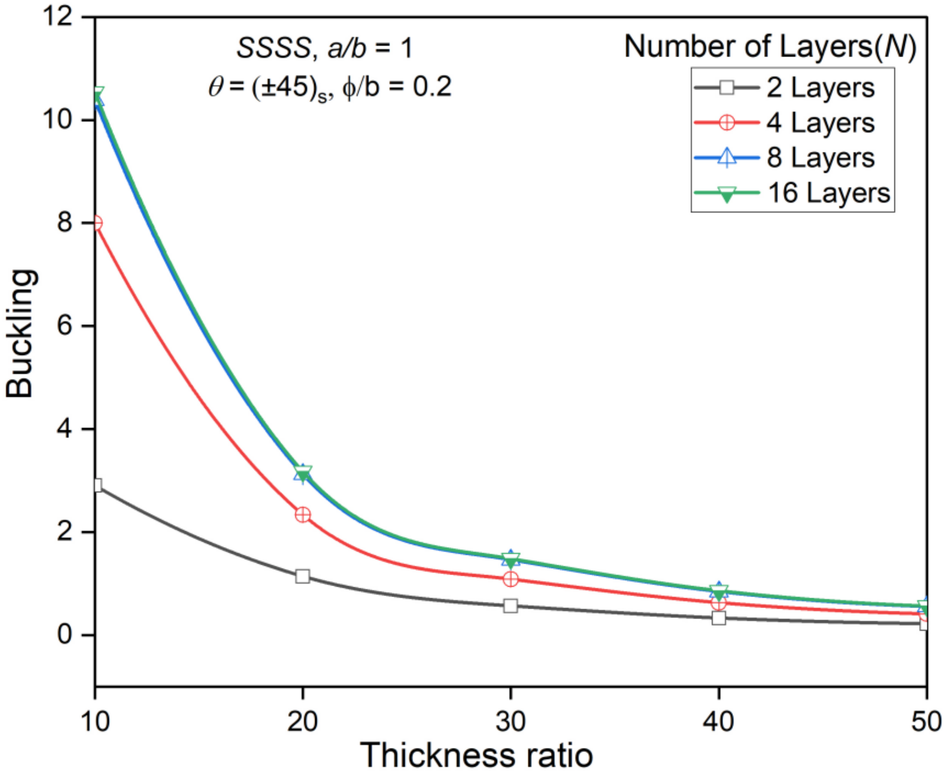

Figure 3 : Effect of number of layers under SSSS

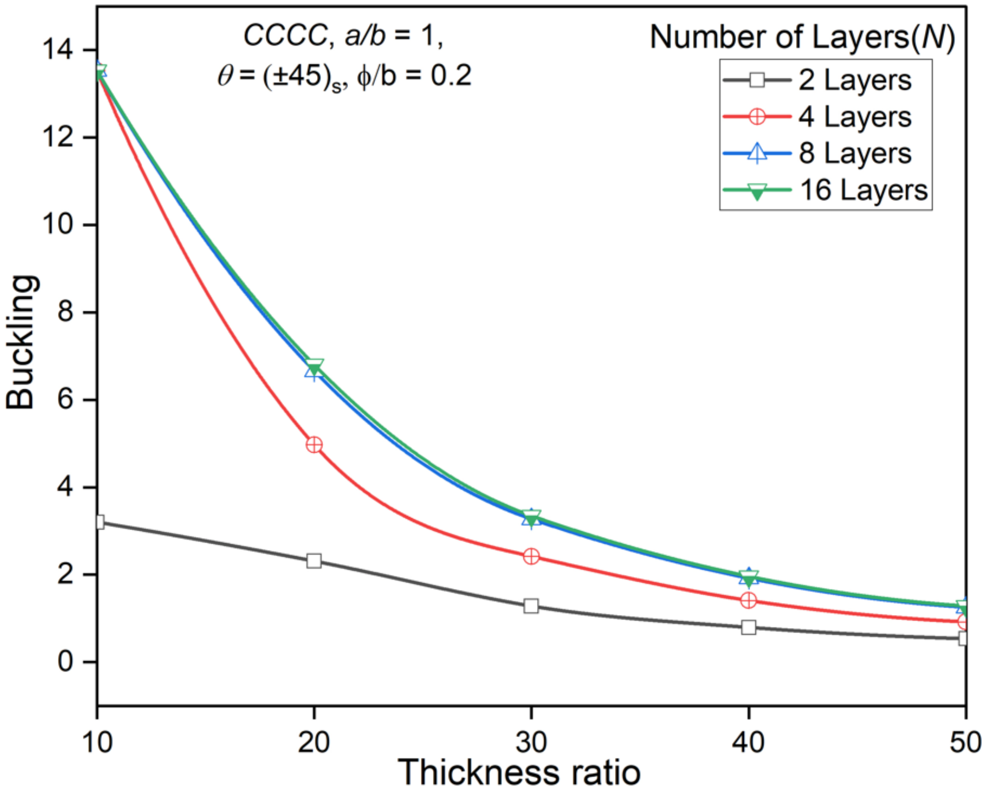

Figure 4 : Effect of number of layers under CCCC

The distinctive pattern of deformation that a structure exhibits when buckling or vibration takes place in a particular mode is known as its mode shape. Mode shapes are used by structural engineers to explain how a structure deforms in response to buckling loads or natural frequencies. A structure (such a composite plate) may flex and collapse when in-plane compressive forces rise. The first buckling mode shape depicts the deformation pattern at the lowest critical buckling load. The first mode shape, which often has the most straightforward deformation pattern, is linked to the lowest buckling load. Larger mode forms are produced by more complicated deformations (having more waves or curvatures) and greater loads. A square cutout causes deformation to concentrate around the cutout, affecting both the plate strength and the mode shape. The buckling behavior is significantly influenced by the cutout's size and location.

Under different in-plane compressive stress conditions, the shape of the first buckling mode of a square-cutout rectangular composite plate depends on a number of critical parameters. When talking about plates, "aspect ratio" describes how the length to width ratio is. The location and size of the square aperture. The stacking order and orientation of the fibers are critical factors in the composite layers.

III. CONCLUSIONS

The characteristic pattern of deformation that takes place in a structure when it undergoes buckling or vibration at a particular mode is referred to as the mode shape associated with that mode. Mode shapes are a useful tool in structural analysis because they serve to describe how a structure deforms when subjected to different buckling loads or natural frequencies. Structures such as composite plates have the potential to bend and become unstable when experiencing an increase in in-plane compressive loads. A description of the deformation pattern at the least critical buckling stress is provided by the first buckling mode shape. Because it is connected with the lowest buckling stress, the initial mode shape often exhibits the simplest deformation pattern. This is because of the characteristics that it has. The higher mode forms display more intricate deformations, such as extra waves or curvatures, when they are exposed to greater stresses. Both the mode shape and the plate integrity are impacted when a square cutting is performed, which might result in localized deformation to the plate. A significant influence on the buckling behavior is exerted by the dimensions of the cutout as well as its location.

REFERENCES

[1]. Ghannadpour, S.A.M., Najafi,A., Mohammadi,B.: Buckling of Cross-ply laminate composite plates due to circular/elliptical cutouts. Compos.Struct.27 pp. 3-6 (2006).

[2]. Afsharmanesh, B., Ghaheri, A. and Taheri-Behrooz, F. (2014), "Buckling and vibration of laminated composite circular plate on winkler-type foundation", Steel and Composite Structures, 17(1), 1-19.

[3]. Y. Zhang, C. Yang, Recent developments in finite element analysis for laminated composite plates, Composite Structures 88(1) (2009) 147-157.

[4]. M. Dehghan, G.H. Baradaran, Buckling and free vibration analysis of thick rectangular plates resting on elastic foundation using mixed finite element and differential quadrature method, Applied Mathematics and Computation 218(6) (2011) 2772-2784.

[5]. R. Mania, Buckling analysis of trapezoidal composite sandwich plate subjected to in-plane compression, Composite Structures 69(4) (2005) 482-490.

[6]. B.O. Baba, Buckling behavior of laminated composite plates, Journal of Reinforced Plastics and Composites (2007).

[7]. Ganesh Soni, Ramesh Singh and Mira Mitra, Buckling behavior of composite laminates subjected to nonuniform In-plane loads, International Journal of Structural Stability and Dynamics 2013.

[8]. Topal U, Uzman U (2008) Maximization of buckling load of laminated composite plates with central circular holes using MFD method. Struct Multidisc optim35:131-139.

[9]. Khdeir AA. Free vibration and buckling of symmetric cross-ply laminated plates by an exact method. J Sound Vib 1988; 126:447–61.

[10]. F. Millar, D. Mora, A finite element method for the buckling problem of simply supported Kirchhoff plates, Journal of Computational and Applied Mathematics 286 (2015) 68-78.

[11]. Jain,P., Ashwin,K.. Post buckling response of square laminates with a central/elliptical cutout. Compos Struct. 75, (2004).

[12]. Aydin Komur.M et al. (2010) Buckling analysis of laminated composite plates with an elliptical/circular cutout using FEM. Advances in Engineering Software 41: 161-164.

[13]. B.O. Baba, A. Baltaci, Buckling characteristics of symmetrically and antisymmetrically laminated composite plates with central cutout, Applied Composite Materials 14(4) (2007) 265-276.