Chapter 12
Structural Optimizations of Different Load-Carrying Members Based on Low Structural Performance Through Computational Structural Analysis:
Structural Optimizations of Sandwich Composite Through FEA Approach

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ABSTRACT

Load withstanding characteristics are one of the major considerations involved in structural engineering because the lifetime factor is directly proportional to load withstanding behavior. Thus, this work computationally analyzes the load withstanding behavior of various sandwich lightweight composite materials under the given flexural load. In this work, four major materials are imposed under flexural loads for two different cum prime core structures such as hexagonal cross-section and twisted cum in-

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tegrated pentagonal cross-section. The major materials implemented for this comparative investigation are Aluminium Alloy, CFRP, GFRP, and KFRP. All the computational composite models are constructed through the advanced computational tool (i.e., ANSYS Workbench). Finally, the best structures with respect to their lightweight materials are shortlisted to withstand a high amount of flexural loads. According to this comprehensive study, the CFRP-based honeycomb sandwich composite performed better than all other lightweight materials.

INTRODUCTION

Due to their structural characteristics, man-made honeycombs are widely manufactured by using a variety of different characteristic materials, depending on the application. This chapter deals with the structural behavior of twisted pentagonal and hexagonal honeycomb and their comparison for suitable application. The honeycomb structure panel, which is columnar and hexagonal in shape, packaged arrangement, inspired from beehives. It provides a material with minimal density which has high compressive and shear properties. The strength of the sandwich panel depends on the panel size, facing material, number (density) of cells in the panel. The combination of hexagonal and pentagonal facing with pyramidal nature is jointly implemented and attained the innovative shape called twisted pentagonal structure. The building blocks of these structures are epithelial cells which are pack tightly to form the lining of blood vessels and organs in animal tissues and human skin.

LITERATURE SURVEY

In this paper, the author brought the number of degrees of freedom for FE discretization is significantly reduced by replacing the core with a homogeneous continuum. The author found that for in-plane behavior, bending and dynamic modal analysis, the agreement between predictions obtained with the continuum plate model and those with the detailed FE model is good. For the coupled behavior of the sandwich under combined bending and in-plane forces, the agreement is not good. A single-layer model-based 2-D computational approach is carried to predict the structural behaviors of cellular core sandwich panels. The 2-D approach had given acceptable predictions than the results obtained by a detailed finite element model on both static and dynamic behavior of orthotropic truss core sandwich panels such as the standard pyramidal truss core and Kagome truss core having pyramidal sub-geometry. However, the author describes that the 2-D model approach is accepted, when the size of the unit cell varies within certain ranges. Strong corrugated sandwich cores are obtained better accurate predictions than weak cores (Liu T et al., 2007).

In this paper, the author demonstrates that stiffness performance is better for a honeycomb-cored sandwich than a metal foam-cored sandwich. The author analyzed and found that the weight index of the honeycomb-cored sandwich is much smaller and the weight index of the metal foam-cored sandwich is larger. Weight reduction of beams is done in both ways, one by modifying the structural design of the beam and the other by changing the parental material. The author concluded that load-bearing capacity is more efficient for stretching-dominated 2-D lattice (Triangular, Kagome) sandwich beams than bending-dominated 2-D lattice sandwich beams for all load indices (Mirrudula P et al., 2020).

In this paper there are five important studies are described: 1. For face wrinkling and structural buckling under different loading cases, the analytical criteria are used and are optimized for sandwich