



Stacking sequence optimization of FRP composites for maximization of failure strength based on Tsai – Wu criterion using genetic algorithm

N.S. Kumar

Principal, Jagans College of Engineering & Technology, Nellore, AP, India.

E-mail: shyam_nsk@yahoo.com

Abstract

Composite materials in mechanical, aerospace, and other branches of engineering are increasingly used due to their excellent weight saving and the ease of tailoring. In spite of tremendous progress in analytical capability to analyze the behavior of composite materials and structures, there is a lack of design models which may allow efficient tailoring of their properties to specific requirements for structural components. To improve this long-pending problem, the optimum design of composite materials has been a subject of research for many years. Strength was considered as constraints in many problems. The present paper treats the optimal stacking sequence design of carbon/Epoxy composite lamina under in-plane loading for maximum strength. Tsai–Wu failure criterion is taken as objective function. Genetic Algorithms are generally used for stacking sequence optimization problems. Genetic algorithm is a direct search algorithm based on probability based optimization. Classical laminate theory is used to establish relations between applied loads, stresses and strains in any layer of a laminate.

Key words: *Stacking sequence, Lamina, Tsai-Wu failure criterion, Roulette wheel selection, mutation, Crossover*

1. Introduction

The usual object of optimum design is to design layer thickness or layer orientation which will give the minimum weight or the maximum strength under in-plane or transverse loadings. In practical use the fiber angles in laminate are limited to small sets comprises of 0° , $\pm 15^\circ$, $\pm 30^\circ$, $\pm 45^\circ$, $\pm 60^\circ$, $\pm 75^\circ$, $\pm 90^\circ$. Hence ply angles are

restricted to take any of the above.

Strength was considered as constraints in many problems. There are, however, a few studies which consider the strength criterion as an objective function of optimum design. Quadratic failure criteria such as Tsai–Wu theory has been used widely for predicting failure of composite materials subjected to combined stress.

2. Lamina Stress strain relations