

ABSTRACT

The necessity of composites in our daily life has become very important from domestic household products to industrial products. Among these, the composite plate and shells have numerous engineering applications like automobile body parts, air craft covering, ship building, sports belongings, etc. The industries with large scope for laminate composite structures are mainly shipbuilding, wind turbine and aerospace, owing to their advantage of light weight to strength. The composites have a strongly emerging market with a high potential high performance and lightweight structures. Modern composites intend to provide an equivalent value of strength with very high reduction in weight of the component. Air craft components and its structural members are preferably made of fiber reinforced composites with better strength & stiffness at lesser weight. The strength of reinforced composites is achieved through positioning of reinforcement members along the direction of load acting on it. By this methodology, a considerate increase in load carrying capacity (tensile strength and modulus of unidirectional elasticity) was observed with minimum strength along the transverse direction of fibre.

Beams and plates comprising of thin-walled structures are unstable at a relatively high temperature and thus they buckle in the elastic region. These members subjected to dynamically varying loads because of ever changing work atmosphere and radiation. Under these circumstances, sudden failure will occur in columns or plates due to raise in deflection value. This impact load and displacement value leads to thermal buckling failure. Composite plates are subjected to elevated temperatures at times of operation and develop thermally induced compressive stresses leading to thermal buckling in aircrafts. Hence analysis of thermal behavior of material attracts much importance in these days.

The wings are subjected to such non-uniform thermal loads due to the changes in running conditions at elevated heights. Thus, the composite that are used in such specific applications must be designed to possess properties that facilitate withstanding against the non-uniform thermal loads. So, this research concentrates on improving the thermal buckling strength. In order to improve the strength under thermal loading, it is essential to control the important governing factors. Here, the stacking sequence and the ply angle are identified as governing factors and varied for different supporting conditions in order to improve the critical buckling strength. As thermo-mechanical properties of Fiber-reinforced laminated composite structure are considerably influenced through the direction of fibers and stacking sequences, they are optimally varied in this research work to maximize the critical buckling temperature of the composite plate subjected to non-uniform thermal load. The use of evolutionary optimization techniques is preferred over the traditional approaches for designing of composites. The optimal values of these controlling parameters have been found with Genetic algorithm. The ply angle and stacking sequence of the laminated composite plate is optimized using genetic algorithm to maximize the thermal buckling temperature. Finite element analysis has been used to analyse the effect of ply angle and stacking sequence under non uniform thermal loading for maximizing the buckling strength at critical buckling temperature. Also, the structure was analysed with and without HAT stiffeners for clear understanding about the impact of stiffeners in thermal buckling of components made from laminate composite. The modelling and analysis was carried out with the finite element software called ABAQUS and the stacking sequence was randomly generated by interfacing ABAQUS and MATLAB. Parametric analysis has also been conducted to investigate the effect of aspect ratio, supporting conditions and non-uniform loading conditions. The mathematical results evidently shows that the requirements that the optimum ply angle and stacking sequences are significantly changing based on the aspect ratio, support conditions, and non-uniform loading cases. The thermal buckling behaviour of each laminated composite sheet under various boundary conditions was analysed. A comparison

study on the results of the proposed work with earlier works have revealed that, there was a slight increase in critical buckling temperature with an estimated reduction of error by 4%. Also, the numerical results prove that, the critical influencers that controlled the buckling strength were geometry and supporting conditions.