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Optimal Design of Laminated Composite Plates by using Advanced G A. A REVIEW

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ABSTRACT: Alliot et al. [1] who used GAs for solving conflicts in air traffic control. Davis [2] and Giffer [3] applied genetic algorithms to problems involving job shop and production scheduling, respectively. These, along with countless other researchers have found GAs to be a valuable tool in problem solving and optimization environments.Although the high strength-to-weight properties of composite materials are attractive, their greatest advantage is that they provide the designer with the ability to tailor the directional strength and stiffnesses of a material to a given loading environment of the structure [4].is the latest and most technically advanced commercial transport aircraft, the Boeing 777. The structure of this revolutionary aircraft, which first flew in 1994, is only comprised of 9% by weight of composite materials [5].

The idea of a genetic algorithm was thought to have been conceived by John Holland at the University of Michigan in the 1970s. Holland [6] was interested in applying the laws of natural selection towards the development of artificial systems rather than systems that are based on some reasoning process [7]. These artificial systems could be constructed using computer software and applied to various disciplines which emphasize design, optimization and machine learning.Two of the most popular implementations of crossover are one-point and two-point crossover where the chromosome string of each parent organism is randomly split at one or two points, respectively. Pieces from each parent organism are then recombined to create a child. Many different types of crossover have been implemented as seen in Le Riche [8] who experimented with no fewer than seven derivatives of this operator.to the other crossover methods, a child is partially comprised of chromosomes from both parent strings. The remaining chromosome(s) in the child string consist of genes that contain averaged information from genes in the corresponding parent chromosomes. This type of operator also works well with gene strings that contain both real and integer values [9].
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The **inversion operator** works in the same manner as permutation but keeps track of the position of each gene at all times. Inversion is typically used to prevent genes in the string that are physically far apart from one another to be unaffected by crossover [10]. When dealing with constrained optimization problems, **repair operators** are sometimes used to guide the GA from unfeasible to feasible areas of the design space. Repair operators have been found to be most effective when implemented with a small probability [11] to prevent the GA from getting stuck in one area of the design space.

Sequential linearization is a standard approach to solving non-linear problems but can often get trapped in local optimum design areas [12]. Thirdly, rounding off design variables when using continuous optimization methods haven shown to produce sub-optimal or even unfeasible designs [13].

In recent years, genetic algorithms have been successfully applied to large, non- convex, integer programming problems, see for example Hajela [14] and Rao et al. [15]. Thus, it was obvious that GAs would be well suited for the design and optimization of laminated composite plates. Early works include Callahan [16] who used GAs for stacking sequence optimization of composite plates, and Nagendra [17, 18, 19] who did extensive research work with GAs and stiffened composite panels. As discussed in Section 1.2, GAs are excellent all-purpose discrete optimization algorithms because they can handle linear and non-linear problems or noisy search spaces by using payoff (objection function) information only.

[20] Prem kumar,A 2001, "Optimal design of multilayer composite plate using Simulated annealing method", M.E. Thesis project work, department of Mechanical engineering, AU.

In early works, Foye [21] used a random search method to find the optimal stacking sequence with the smallest number of plies, while satisfying strength and stiffness requirements. Waddoups [22] employed a brute force method in which all possible designs were evaluated. In both studies [23] and [24] multiple in-plane loading conditions were considered and ply orientation angles and the number of plies were treated as design variables. Verette [21] and Kenoshi [24] conducted laminate optimization studies that used stability constraints based on simplified buckling analyses to avoid complications involved with solving eigenvalue problems.

The objective function and stiffness constraint were found to be linear functions of the design variables and the strength constraint, which was non-linear was transferred to set of sequential linear problems that could be solved easily [25].

This approach was also successfully applied to the problems involving buckling by sequentially linearizing the buckling constraint with respect to the ply thicknesses [26]. G¨urdal [27] used continuous optimization in conjunction with a penalty function to force the ply orientation angles to discrete values.

Haftka and Walsh [26] solved the stacking sequence problem for buckling load maximization. The non-linear problem, resulting from using ply thicknesses as design variables, is linearized by using ply-orientation-identity variables, and then solved using a branch and bound algorithm.

Many recent studies have concentrated on improving the genetic algorithm's reliability and efficiency. Le Riche and Haftka [28] studied the problem of composite panel weight minimization subject to buckling and strength constraints.

The studies can be used to formulate trade off studies between cost and weight which may aid in the selection of a design that minimizes cost and/or weight [29], two of the most important considerations in aerospace applications.

. Kassapoglou [29] used multi-objective optimization to simultaneously minimize the cost and weight of composite stiffened panels subjected to compression and shear loads. The first step in the optimization procedure involved minimizing each parameter separately. The lowest weight and cost configurations were then identified and placed in the Pareto-optimal set. Designs from the group optimized for cost that were lighter than the minimum cost configuration, and designs from the group optimized for weight that were cheaper to fabricate than the minimum weight configuration comprised the remainder of the candidate Pareto-optimal set. The optimum configuration from this set was chosen to be the one that minimized a certain penalty function. Although the individual minimum weight and cost designs did not coincide, results showed that a set of near-optimal designs could be found. Panels configured with "J" stiffeners provided the lowest weight, while "T" stiffeners produced the lowest cost designs and the best tradeoff between cost and weight. GAs have also been applied to multi-objective problems. Schaffer [30] used genetic algorithms for multi-objective problems by creating equally sized sub-populations. Each sub-population worked on optimizing a single objective. Although selection was carried out in each sub-population individually, crossover was performed between members of both populations. Results showed that this implementation scheme was susceptible to bias against individuals that satisfied both objectives well but did not provide the optimum solution for either criteria, making it difficult to find the entire set of Pareto-optimal designs. Belegundu et al. [31] implemented a GA in a slightly different manner for multi-objective optimization of a wide range of problems. The selection procedure in the GA was modified by replacing traditional roulette wheel selection with a scheme based on dominated and non-dominated designs.

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