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TOPOLOGY OPTIMIZATION OF PLATES AND SHELLS USING HYBRID GENETIC ALGORTHM

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ABSTRACT

In this paper we present the application of Hybrid Genetic Algorithm for Optimal Topologies of plates and shell structures. Presently the main approach for seeking optimum design is based on Homogenization [1], or Artificial density methods [2] or by Evolutionary structural optimization method [3] for reasons of computing efficiency. The authors' team has been studying in depth the Genetic Algorithm based methods[4, 5] to achieve better optima from a global search point of view particularly since computing costs have come down considerably.

The Hybrid GA [6] in the case of a topology optimization is a three phase method wherein a two stage GA [7] is used in the first two phases in which the object is represented using a boolean representation (void/fill) with respect to a base mesh spanning over a rectangular reference region. The problem is formulated as a volume minimization problem with constraints on external work under different load conditions. The progress of Topology Optimization is monitored by studying the nodes and branches in the best design in each generation using skeletonization. At an appropriate stage when the topological designs evolving during the process are few a switch to geometric variables is made and the GA process is continued. The design slowly converges to a stable skeleton and once this is achieved, the GA process is terminated and Nonlinear programming based optimization is adopted in the third phase to optimize the geometric variables corresponding to the chosen skeleton.

Two sets of benchmark problems one corresponding to plates and another for shells are solved for different loading and boundary conditions Adaptive domain reduction is used in a sequential manner to keep the number of design variables under control.

The results are compared with the solution obtained using the Artificial density method. The comparison in carried out for computing effort, nature of global optimum and the ease of handling stress constraints. The impact of the use of approximate FE analysis is also studied. It is seen that the convergence of the Hybrid GA for Topology Optimization is very smooth and the algorithm is robust with the optima better than

those obtained by the other local search algorithms. The trend is similar to the one reported for 2D / 3D problems earlier. The number of the FE analyses is large for the Hybrid GA method and the ratio of computing effort for an LP solution to one FE analysis is much smaller for the plate and shell problem in comparison with 2D / 3D problems. This results in larger computing effort for the present approach. However with large computer clusters being available at affordable cost now, the day may not be far when the other advantages of Hybrid GA may outweigh the traditional methods.

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