OPTIMUM DESIGN OF TRUSSES FROM AVAILABLE SECTIONS

By

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D E D I C A T E D TO

MY

P A R E N T S

CERTIFICATE

This is to certify that the thesis entitled OPTIMUM DESIGN OF TRUSSES FROM AVAILABLE SECTIONS being submitted by Mr. K.V. John to the Indian Institute of Technology, Delhi for the award of the Degree of Doctor of Philosophy in Applied Mechanics Department is a record of bonafide research work carried out by him. He has worked under our guidance and has fulfilled the requirements for the submission of thesis which, in our opinion, has reached the requisite standard.

The results contained in this thesis have not been submitted in part or full, to any University or Institute for the award of degree or diploma.

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(K.V. John)

ABSTRACT

Optimum structural design of trusses from available sections is a practical problem of great value with applications in the design of antennas, microwave towers, transmission towers and other civil and aeronautical engineering structures. Mathematical programming techniques and optimality criteria methods are two approaches which have been extensively used in the past. Here, a primal formulation of the problem and the use of improved move limit method of sequential linear programming with hybrid optimality criteria approach is proposed and its performance is compared with other algorithms. Here, the stress and displacement constraints have been considered.

For solving problems wherein a choice of member sections has to be made from an available set, a branch and bound algorithm is developed. A large number of test problems have been tried and the optimal solution has been obtained although it has been found to be computationally expensive. A simple two step procedure is suggested for practical problems wherein allowable compressive stresses in the members are determined from their slenderness ratios. A continuous solution is obtained for the problem using continuous 'a' - 'r' curve between areas and their corresponding least radii of gyration. This is converted to a discrete solution by two approximate methods - either by a heuristic selection of areas or by the discrete programming

technique at the end. This has been found to do well and give good results comparable to the discrete programming solution with much less computational time.

The optimal design of trusses with stress, displacement and frequency constraints has been taken up for the study next. Here, the natural frequencies of the structure have to be restricted to fall outside a prescribed band. The improved move limit method of sequential linear programming is effectively applied for these problems. The discrete solution for these problems are determined by branch and bound algorithm. Another approximate method for the solution of this problem is to convert the continuous solution to a discrete one by employing the discrete programming approach at the end. Several test and practical problems have been solved and the results by the two methods have been compared.

The shape optimization with co-ordinate variables as unknowns is another practical problem solved in this thesis. The improved move limit method of sequential linear programming is effectively merged with a feasible direction method or steepest descent method for the solution of this problem. The approximate method of converting the continuous solution to a discrete one by heuristic selection is effectively employed to get a useful practical solution of the problem from available sections.

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