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Contributions to Integrated Programs Systems for Structural Analysis

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Summary

The thesis presents an integrated design program that allows both structure design and optimization in one cycle, with minimum user intervention. This program includes an original hybrid algorithm for structural optimization, that uses finite element method and genetic algorithms. The description of the algorithm basis, working parameters and two case studies are also presented. The results show a reduced number of iterations, with a minimum computational effort in optimization process, that allow a geometrical optimization of structures.

The intelligent integrated system is realized using Finite Elements Method and Genetic Algorithms. In the mean time, the structure of the program calls mathematical programming methods for optimization, particularized for geometrical optimization of structures.

Chapter 1 makes an introduction to the purpose of the thesis, presenting the content of each chapter.

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Chapter 2 presents the Finite Elements Method and different ways of integrated calculation and systems. Calculation systems based on Finite Elements Method include different calculation types. Input data and results differ depending on the general enounce of the problem. Intelligent calculation modules can be linked to the calculation programs, using the input data and results.

Chapter 3 is centered on several intelligent computational methods that can be applied into structural engineering field. Genetic algorithm method is presented in detail.

Chapter 4 presents briefly the characteristics of integrated calculation systems. Integrated calculation programs for structural engineering are widely spread, but there is a poor literature that describes them. Therefore, the problematic moves to computer science and programming fields.

Chapter 5 presents classical mathematical optimization methods. Optimization problems were divided in two types: with restrictions and without restrictions.

Chapter 6 describes in detail the original algorithm for integrated intelligent optimization, as well as the original proposed program. The architecture of the elaborated algorithm is based on a set of observations on structure design problematic and on optimization in general.

Chapter 7 presents two relevant case studies, for 2D and 3D Truss Structure Optimization.

Chapter 8 is reserved to conclusions and reveals the original contribution to Integrated Programs Systems, as well as future research directions.

This thesis contributes to the calculation integrated systems development, by developing a new intelligent integrated design system, applied to the structural optimization field. The integrated optimization system proposed has the following general characteristics: it works integrated, and it uses the finite elements method for structure calculation, and genetic algorithms for finding the optimum.

The optimization algorithm proposed is a strong optimization method. It reaches the optimum criteria after a reduced number of iterations, with a minimum computational effort. Genetic Algorithms can be used together with traditional calculation methods, in order to improve both methods' performances. Implementing an optimization algorithm that functions integrated brings significant design benefits.

Keywords: optimization, integrated system, genetic algorithm.

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