Analysis of Structures by Optimization Method (ASOM) Applied to Geometrical Stability of 2D-Frames

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Abstract

A method for analysis of structures by minimization of total potential energy using optimization methods is introduced. Theoretical basis for analysis of two-dimensional frames is presented. Formulation for check of stability of structures and stability analysis of columns is derived. Through analysis of examples efficacy and robustness of the method is verified.

Keyword: *ASOM, minimization, total potential energy, and two-dimensional frames.*

1. Introduction

Use of principle of total potential energy in structural mechanics is an old issue. Deriving equations of equilibrium in known equilibrium methods of analysis, such as finite element method, is based on this principle. Analysis of structures by optimization methods (ASOM) is a new approach in structural analysis. In this approach the total potential energy is considered as an objective function. This function is defined in terms of nodal displacements of the structure (variables). The problem of structural analysis is reduced to finding values of variables, which minimize the total potential energy. This is a standard optimization problem that may be stated as follows:

$Minimize \quad U = f(x_i), \quad i = 1, n$

$Subject \ to \quad g(x_j), \quad j = 1, k$ **(1)**

In which U is total potential energy, x_i, i=1,n are variables. A large number of available optimization methods [1-2] may be used. Analysis of truss structures by minimization of total potential energy is reported in reference [3] to [5]. Recently the author applied ASOM in analysis of two-dimensional framed-structures [6]. The method is found to be very interesting and effective in the sense that the same algorithm may be used in analysis of linear and non-linear structures. Moreover the computer programming efforts needed in implementation of the method is much smaller than in known equilibrium methods.

In this paper, ASOM is developed for checking the geometrical stability of the structures. Stability analysis of columns is another issue tackled here. The paper is arranged in the following forms. The ASOM is introduced in section 1. In section 2 the formulation for analysis of two-dimensional frames is developed. Checking the