An efficient graph-theoretical force method for three-dimensional finite element analysis

A. Kaveh[1,*,†] and K. Koohestani[2]

[1]*Centre of Excellence for Fundamental Studies in Structural Engineering, Iran University of Science and Technology, Narmak, Tehran 16, Iran*
[2]*Department of Civil Engineering, University of Tabriz, Tabriz, Iran*

SUMMARY

In this paper an efficient method is developed for the formation of null bases of finite element models (FEMs) composed of tetrahedron elements, corresponding to highly sparse and banded flexibility matrices. This is achieved by associating special graphs with the FEM and selecting appropriate subgraphs and forming the self-stress systems on these subgraphs. The efficiency of the present method is illustrated through two examples. Copyright © 2007 John Wiley & Sons, Ltd.

1. INTRODUCTION

The force method of structural analysis, in which the redundant forces are used as unknowns, is appealing to engineers, since the properties of members of a structure most often depend on the member forces rather than on joint displacements. This method was used extensively until 1960. After this, the advent of digital computer and the amenability of the displacement method for computation attracted most researchers. As a result, the force method and some of the advantages it offers in non-linear analysis and optimization have been neglected.

Four different approaches are adopted for the force method of structural analysis, which are classified as:

1. topological force methods;
2. algebraic force methods;

---

*Correspondence to: A. Kaveh, Department of Civil Engineering, Iran University of Science and Technology, Narmak, Tehran 16, Iran.
†E-mail: alikaveh@iust.ac.ir