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Analysis of symmetric structures using canonical forms

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SUMMARY

Canonical forms are recently employed in eigenproblems of structural mechanics to calculate the eigenvalues and eigenvectors. In this paper, such applications are extended to the static analysis of symmetric structures. In classical approaches the structure is decomposed into substructures and appropriate boundary conditions are then imposed. Here, a systematic method is developed which does not operate directly on the structural model, but rather on the matrices involved in the analysis of the structures. Copyright © 2006 John Wiley & Sons, Ltd.

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KEY WORDS: structural analysis; canonical forms; symmetry; anti-symmetry; Form II; Form III

1. INTRODUCTION

Symmetry has been widely studied in science and engineering [1–5]. Large eigenvalue problems arise in many scientific and engineering problems [6–8]. While the basic mathematical ideas are independent of the size of matrices, the numerical determination of eigenvalues and eigenvectors requires additional considerations as the dimensions and the sparsity of matrices increase. Special methods are needed for efficient solution of such problems.

Methods are developed for decomposing the graph models of structures in order to calculate the eigenvalues of matrices with special patterns, Reference [9]. The eigenvectors corresponding to such patterns are studied in Reference [10]. The application of these methods in extended to the vibration of mass–spring systems [11] and free vibration of frames [12].

Recently, canonical forms are employed for calculating the eigenvalues and eigenvectors of different problems in structural mechanics. In this paper, these applications are extended to the static analysis of symmetric structures. In traditional methods a given structure is often

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