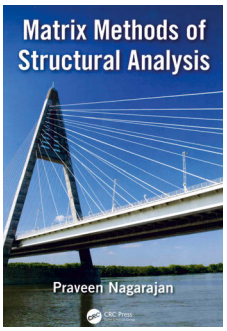
Review

This detailed book with excellent examples and illustrations will make a useful reference text on matrix methods of analysis, concludes Ian May.

Matrix methods of structural analysis



Author: Praveen Nagarajan
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As the title states, the subject of this book is the matrix methods of structural analysis, in particular the stiffness and flexibility methods applied to the linear elastic analysis of framed structures. As readers will likely be aware, the matrix stiffness method is the technique used in the multitude of computer packages available for frame analysis and design.

The book comprises five chapters. The first covers, briefly, coordinate systems, equivalent nodal loads, and a useful section on indeterminacy, but assumes the reader has prior knowledge of the derivation of fixed-end moments for beams, the limitations of superposition, etc.

In the first part of the second chapter, the stiffness and flexibility matrices for truss, beam, and space-frame elements are derived. It is assumed that the reader has a basic understanding of the element stiffness relationships and understands the use of product integrals. The second part of the chapter gives a review of energy methods and an alternative derivation of the stiffness and flexibility coefficients using an energy approach.

Chapter 3 continues on from the previous chapter to use the member flexibility matrices to develop the matrix flexibility method for the analysis of structures. A number of examples of the use of the method to determine displacements in statically determinate structures are given. This is followed by extending the method to determine both the displacements and internal forces in statically indeterminate structures. Finally, the effects of lack of fit of members and thermal changes are considered and included in the method.

"EACH CHAPTER HAS NUMEROUS EXAMPLES TO ILLUSTRATE THE APPLICATION OF THE THEORY. EACH STEP IS DESCRIBED IN DETAIL"

Chapter 4 deals with a matrix stiffness approach in a similar way to that used in Chapter 3 for the flexibility method, using the member stiffness matrices developed in Chapter 2. Some additional general structural theory is included, e.g. the principle of contragradience. As for the matrix flexibility method examined in the previous chapter, there are numerous examples to explain the method thoroughly.

The first part of the final chapter, Chapter 5, is concerned with the direct stiffness method, i.e. the method than forms the basis of the majority of structural programs. The second part gives a short but useful introduction to the non-linear analysis of structures and discusses both material and geometric non-linearities.

The appendix contains a MATLAB code for the analysis of plane trusses, which appears to serve little purpose as there are many free computer software programs available for the linear analysis of beam, truss and space-frame structures.

Each chapter has numerous examples to illustrate the application of the theory. Each step is described in detail to help the reader; this can be very helpful as the author has explained parts of the analysis which are often glossed over in textbooks. The illustrations are excellent.

It is difficult to decide what audience the book is aimed at. There are too many gaps for it to be a mainstream undergraduate text, e.g. very little about superposition, assumption of understanding of the unit load method. It also includes a significant amount of material, e.g. the matrix flexibility method, which would be of little value in an undergraduate course, as it is not used to any extent in practice.

In general, the analysis of a structure can be considered to comprise three parts: the modelling of the structure and loadings, solution of the structural equations, and verification of the results. While in practice it is the modelling and verification that require most engineering judgement and should form a significant part of an engineer's education, this book only covers the solution of the structural equations.

The presentation of a wide range of topics often not included in basic structural textbooks could make it a useful reference for undergraduate and postgraduate students and for engineers responsible for structural analyses.

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Ian was, prior to his retirement, Professor of Civil Engineering at Heriot Watt University, Edinburgh. His research interests included impact, and fatigue behaviour and repair of structures involving both large-scale testing and numerical modelling. He was also particularly interested in the teaching of structural analysis.