Exact dimensionless natural frequencies of non-prismatic Euler-Bernoulli beams

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Abstract

In this work a tapered Euler-Bernoulli beam in which the exact dimensionless natural frequencies and some shape functions for three modes are obtained by satisfying the dynamic homogeneous differential equation of non-prismatic Euler-Bernoulli beam is developed. Variation of beam in this paper is such that A (beam cross section area) varies as x^n and I (beam moment of inertia) varies as x^{n+2}. Also four boundary condition is used in this paper: clamped-free, clamped-clamped, clamped-pinned and pinned-pinned beam. It should be noted that in this paper, the governing equation of motion has solved with Bessel functions.

Key words: Non-prismatic beams, shape functions, free vibration, tapered beams

1. Introduction

Due to economic and aesthetic benefits, non-prismatic members are widely used in industry. But using this members, require more computational effort, in comparison with conventional prismatic members (due to approximating a non-prismatic member with several prismatic member). Researchers have adopted many different techniques in their analysis of these structures. One of the best methods for solving this problem is exact dynamic stiffness matrix (EDSM). Due to the many advantages that comes with using the dynamic stiffness matrix, it is became one of the most efficient methods in dynamic analysis of structures. In the conventional method, the dynamic stiffness matrix method is the most accurate methods and sometimes is called the exact solution. The accuracy of this method, unlike the finite element method or other methods of approximation does not depend on the number of Elements. For example, the method of dynamic stiffness matrix of a structural element is enough to calculate any number of natural frequencies with any desired degree of accuracy, while reducing the accuracy of the finite element method and other approximate methods at high frequencies is known. Hence this method as an efficient and unified way, in many cases, such as verification