ANALYSISOFTWO-DIMENSTIONALELASTODYNAMICSPROBLEMS USING THE NOVEL SCALED BOUNDARY BASED DECOUPLED EQUATIONS METHOD

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ABSTRACT

A new modification of a semi-analytical technique based on the Scaled Boundary-Finite Element Method (SBFEM) is proposed for solving 2D elastodynamic problems. In this method, the boundary of the problem domain is discretized by a set of special sub-parametric boundary elements as; higher-order Lagrange mapping functions and a kind of special shape functions are used and these interpolated functions are set up on Gauss-Lobatto-Legendre nodes. Using the weighted residual method and implementing Gauss-Lobatto-Legendre integration, the coefficient matrices of equations system become diagonal, which results in a set of decoupled governing equations for the whole system. This means that the governing equation for each degree of freedom is independent from others of the domain. Herein, this technique is employed for analysis of two-dimensional elastodynamic bounded problems and loading and the validity and accuracy of the present method are demonstrated through some benchmark problem, using a small number of degrees of freedom.

INTRODUCTION

To solve elastodynamic problems for analysis and designpurposes, numerical approaches are usually employed.Different types of numerical approaches such as Finite Element Method (FEM),Boundary Element Method (BEM), Scaled Boundary Finite Element Method (SBFEM), and meshless methods are routinely used to solve elastodynamic problems.

The use of FEM is advantageous as its procedures are well-established and versatile in nature. On the other hand, BEM requires basically reduced surface discretizations, and may be considered as an appealing alternative to FEM for elastodynamic problems. Since BEM does not require domain discretization, fewer unknowns are required to be stored. BEM needs a fundamental solution for the governing differential equation to obtain the boundary integral equation. Although coefficient matrices of BEM are much smaller than those of FEM, they are routinely non-positive definite, non-symmetric, and fully populated. Combining the advantages of FEM and BEM, SBFEM was successfully developed. Using surface finite elements, SBFEM discretizes only the boundary of the domain by transforming the governing partial differential equations to ordinary differential equations, which may be solved analytically. A modification of the SBFEM with Diagonal coefficient matrices has been proposedby Khaji and Khodakarami (2011) for solving potential problemsand this method is used widely for solving various wave propagation problems (e.g., seeKhodakarami and Khaji (2011), Khodakarami et. al. (2012),Khaji and Khodakarami (2012), Mirzajani et.al. (2013) and Khodakarami and Khaji (2014));

In this study, we improved the efficiency of the semi-analytical approach which is proposed byKhodakarami et. al. (2012); where, the Lagrange polynomials is used as mapping functions instead ofChebyshev polynomials and also Gauss-Lobatto-Legendre quadratureis employed instead of Clenshaw-