A new global nonreflecting boundary condition with diagonal coefficient matrices for analysis of unbounded media. (English) Zbl 1452.74013

Summary: In this paper, a new semi-analytical method is developed with introducing a new global nonreflecting boundary condition at medium-structure interface, in which the coefficient matrices, as well as dynamic-stiffness matrix are diagonal. In this method, only the boundary of the problem’s domain is discretized with higher-order sub-parametric elements, where special shape functions and higher-order Chebyshev mapping functions are employed. Implementing the weighted residual method and using Clenshaw-Curtis quadrature lead to diagonal Bessel’s differential equations in the frequency domain. This method is then developed to calculate the dynamic-stiffness matrix throughout the unbounded medium. This method is a semi-analytical method which is based on substructure approach. Solving two first-order ordinary differential equations (i.e., interaction force-displacement relationship and governing differential equation in dynamic stiffness) allows the boundary condition of the medium-structure interface and radiation condition at infinity to be satisfied, respectively. These two differential equations are then diagonalized by implementing the proposed semi-analytical method. The interaction force-displacement relationship may be regarded as a nonreflecting boundary condition for the substructure of bounded domain. Afterwards, this method is extended to calculate the asymptotic expansion of dynamic-stiffness matrix for high frequency and the unit-impulse response coefficient of the unbounded media. Finally, six benchmark problems are solved to illustrate excellent agreements between the results of the present method and analytical solutions and/or other numerical methods available in the literature.

MSC:
74A50 Structured surfaces and interfaces, coexistent phases
35Q74 PDEs in connection with mechanics of deformable solids

Keywords:
semi-analytical method; global nonreflecting boundary condition; Chebyshev polynomials; sub-parametric elements; soil-structure interaction; unbounded media

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