865. Investigation of vibrations of a two phase material

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Abstract. The model for investigation of vibrations of an elastic structure filled with fluid is proposed. This model is applicable for the analysis of vibrations of soil filled with water and can also be applied for the analysis of vibrations of materials used in various transportation devices. A two-dimensional structure is analyzed and four nodal variables are assumed: displacements of the elastic structure in the directions of the axes of coordinates and displacements of the fluid in the directions of the axes of coordinates. The interaction of the elastic structure and the fluid is assumed through the volumetric strains. This enables to obtain the stiffness and mass matrixes directly applicable for calculation of the eigenmodes of the system. The eigenmode is represented by two figures: the displacements of the elastic structure and the displacements of the fluid. The first eigenmodes of the rectangular structure are obtained and analyzed. An important problem for precise analysis of vibrations of such two-phase systems is the accurate determination of physical parameters used in the analysis. Special experimental procedures are to be designed and implemented for their determination. This is the subject of subsequent investigations and is to be presented in future papers.

Keywords: elastic structure, plane strain, fluid, compressibility, eigenmodes, vibrations, finite elements, penalty method.

Introduction

The model for investigation of vibrations of an elastic structure filled with fluid is proposed. This model is applicable for the analysis of vibrations of soil filled with water and can also be applied for the analysis of vibrations of materials used in various transportation devices.

A two-dimensional structure is analyzed and four nodal variables are assumed: displacements of the elastic structure in the directions of the axes of coordinates and displacements of the fluid in the directions of the axes of coordinates. The interaction of the elastic structure and the fluid is assumed through the volumetric strains. Certainly, in two-phase systems various interactions between the phases are taken into account. But here only this one type of interaction is assumed as it is the most important one for the problems of small vibrations. This enables to obtain the stiffness and mass matrixes directly applicable for calculation of the eigenmodes of the system.

The eigenmode is represented by two figures: the displacements of the elastic structure and the displacements of the fluid. The first eigenmodes of the rectangular structure are obtained and analyzed.

The model for the analysis of vibrations of the investigated two-phase structure is proposed on the basis of the material described in [1-5].

Model for the analysis of vibrations of a two-phase material

Further x and y denote the axes of the system of coordinates. The element has four nodal degrees of freedom: the displacement of the elastic structure in the direction of the x axis denoted as u, the displacement of the elastic structure in the direction of the y axis denoted as v, the displacement of the fluid in the direction of the x axis denoted as u_f, the displacement of the fluid in the direction of the y axis denoted as v_f.