DYNAMIC ANALYSIS OF A THREE-DIMENSIONAL POROELASTIC BEAM USING BOUNDARY-ELEMENT METHOD

A.N. Petrov[1], S.M. Aizikovich[1], L.A. Igumnov[2]
[1]Research and Education Center «Materials», Don State Technical University,
Russia, Rostov-on-Don, 1 Gagarin sqr., 344000
[2]Research Institute for Mechanics of Lobachevsky University,
Russia, Nizhny Novgorod, 23 Prospekt Gagarina, bld. 6, 603950
E-mail: andrey.petrov@mech.unn.ru

The problem of determining the dynamic response of fluid-saturated porous media is very important in many practical applications encountered in, e.g., geotechnical engineering, geophysics, bioengineering and material science and engineering [1]. In poromechanics, the study of the deflection of a poroelastic beam, representing a structural element, a geological layer, or a bone depending on different applications, constitutes an exemplifying model for the application of the poroelasticity theory [2].

Since Biot [3] put forward the basic equations describing the dynamic characteristics of saturated porous media, many scholars have studied the problem of saturated porous medium dynamic from different aspects, including analytical studies of dynamic response of saturated porous media problems [4]. However, due to the complexity of the inertial, viscous and mechanical couplings in dynamic theory, most of the problems of fluid-saturated porous media can often be predicted quantitatively via numerical methods involving discretization of both spatial and temporal domains [5]. In the work, the transient vibration response of simply supported fluid saturated porous beam in a 3D formulation is considered. The problem is solved using a direct approach of the method of boundary integral equations (BIE) corresponding to the initial boundary-value problem of the mathematical theory of poroelasticity. The BIE's are solved using the boundary element method. The influence of pore fluid permeability coefficients and loading frequency values on the solid displacement and pore fluid pressure are studied (Fig. 1). The numerical solutions are compared with analytical solutions other author's.

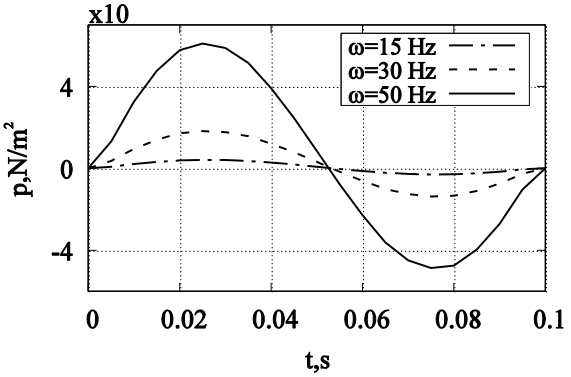

Fig. 1. The fluid pressure along the beam thickness varying with frequency ω

The work is financially supported by the Russian Foundation for Basic Research (RFBR) under grants 15-08-02814, 15-48-02333, 15-08-02817.

REFERNCES

1. Papargyri-Beskou S., Tsinopoulos S.V., Beskos D.E. Transient dynamic analysis of a fluid-saturated porous gradient elastic column // Acta Mechanica - 2011, Vol. 222. - Issue 3–4, -P. 351–362
2. Wang, Z.-H., Prévost, J. H. and Coussy, O. (2009), Bending of fluid-saturated linear poroelastic beams with compressible constituents. Int. J. Numer. Anal. Meth. Geomech., 33: 425–447. doi:10.1002/nag.722
3. Biot M.A. Theory of propagation of elastic waves in a fluid-saturated porous solid, part I: low frequency range // J. Acoust. Soc. Am. - 1956. - Vol. 28. - №2. -P. 168-178.
4. F. X. Zhou, Q. Ma, Dynamic Response of Two-Dimensional Fluid-Saturated Porous Beam, Applied Mechanics and Materials, Vols. 580-583, pp. 169-174, 2014
5. Shan, Z., Ling, D. & Ding, H. Appl. Math. Mech.-Engl. Ed. (2013) 34: 75. doi:10.1007/s10483-013-1654-7