

地球物理学报 » 2009, Vol. 52 » Issue (8) : 2084-2092 doi:10.3969/j.issn.0001-5733.2009.08.017

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引用本文(Citation):

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WANG Xiao-Gang.The non-axial symmetrical transient response of transversely isotropic saturated soils to internal loading.Chinese J.Geophys. (in Chinese),2009,52(8): 2084-2092,doi: 10.3969/j.issn.0001-5733.2009.08.017

横观各向同性饱和地基中埋置荷载的非轴对称瞬态响应

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The non-axial symmetrical transient response of transversely isotropic saturated soils to internal loading

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摘要

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摘要 基于孔隙介质的Biot理论, 首先利用Laplace变换, 给出圆柱坐标系下横观各向同性饱和和弹性多孔介质在变换域上的波动方程; 将波动方程解耦后, 根据方位角的Fourier展开和径向Hankel变换, 求解了Biot波动方程, 得到以土骨架位移、孔隙水压力和土介质总应力分量的积分形式的一般解; 借助一般解, 建立了有限厚度饱和土层和饱和半空间的精确动力刚度矩阵, 并由土层的层间界面连续条件建立三维非轴对称层状饱和地基的总刚度方程; 在此基础上, 系统研究了横观各向同性饱和和半空间体在内部集中荷载激励下的动力响应, 并给出了问题的瞬态解答. 该研究为运用边界元法求解饱和地基动力响应奠定了理论基础.

关键词 横观各向同性, 饱和地基, Biot波动方程, 瞬态解

Abstract: Based on Biot's theory for fluid-saturated porous media, the non-axial symmetrical transient response for transversely isotropic saturated soils under internal loading is studied in this paper. First, the governing differential equations for saturated soils are solved by Laplace transform and operator theory. Then, the general solutions of soil skeleton displacements and pore pressure as well as the total stresses for saturated soils are presented by mean of Fourier expanding and Hankel integral transform. Furthermore, using general solutions, the dynamic stiffness matrix for a layered saturated soils and a saturated half-space are derived exactly, and the global stiffness equation of a multi-layered half-space is assembled by using stiffness matrices and the continuity of tractions and fluid flow at layer interfaces. Finally, the transient foundation solution of transversely isotropic saturated half-space to impulsive concentrated loading is numerically presented. This study provides an effective method to analyze dynamical response between saturated soils and structures by BEM.

Keywords Transversely isotropic, Saturated soils, Biot's wave equations, Transient solution

Received 2008-08-12;

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链接本文:

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