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饱和土中深埋圆柱形衬砌洞室对瞬态平面波的散射

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Scattering of transient plane waves by deep buried cylindrical lining cavity in saturated soil

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摘要

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摘要

基于Biot饱和多孔介质动力学理论,运用Laplace变换和波函数展开法,根据饱和土体与衬砌结构交界面的连续条件和衬砌结构内边界上的应力自由条件,得到饱和土中深埋圆柱形衬砌洞室对瞬态平面P波和SV波散射问题的解答,该解答可以退化成为饱和土中深埋圆柱形空穴或弹性夹杂物的情形,并很容易转换为对稳态波散射的解.通过与已有的相关问题的解析解答进行对比,验证了该解答的正确性.同时利用Laplace逆变换的数值方法,给出了饱和土和衬砌中应力和位移场在时域内的数值解,通过算例,分析了衬砌厚度、刚度对衬砌内边界处应力集中因子的影响.

关键词 饱和土, 瞬态波, 圆形衬砌洞室, 散射, Laplace变换

Abstract:

On the basis of Biot dynamic theory for saturated porous media, this work finds the analytical solutions for two-dimensional scattering and diffraction of transient plane P waves and SV waves by deeply buried cylindrical lined cavity in saturated soil. This process employs the Laplace transform and wave function expansion method according to the continuous conditions of saturated soil and lining structure interface and the stress-free condition on the surface of lining structure. The solutions can be degenerated to the case of deeply buried cylindrical hole in saturated soil or in the elastic medium and under the condition of steady wave incident. The solutions also are proofed by comparison with the existing related solutions. Numerical results are given and the effects of the lining thickness and stiffness on the stress concentration factor of the inside boundary of lining are analyzed.

Keywords Saturated soil, Transient waves, Cylindrical lining cavity, Scattering and diffraction, Laplace transform

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