三排管冻结温度场的势函数叠加法解析解

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ANALYTICAL SOLUTION OF THREE-ROW-PIPED FROZEN TEMPERATURE FIELD BY MEANS OF SUPERPOSITION OF POTENTIAL FUNCTION

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摘要 基于水－热异类相似原理，根据传热过程与地下水流动相似的特点，利用水力学中速度势函数叠加原理，验证了现有的单管、单排管及双排管冻结温度场解析解。进而针对三排管冻结，引入“遮挡系数”，类比推导3排管冻结温度场解析解，并用热学数值模拟方法加以验证。研究结果表明，解析解计算结果与数值模拟结果较吻合，证明推导过程正确，为今后多排管冻结温度场解析解的推导提供一定的思路，得到的结果可靠，能为3排冻结管冻结设计施工提供理论指导。

关键词： 土力学；人工地层冻结；三排冻结管；温度场；解析解；势函数；水&ndash 热异类相似

Abstract： Based on the theory of analogy between thermal and hydraulic problems，using the superposition of potential function in hydraulics，this paper proved the existing analytical solutions of temperature field for the single-piped，single-row-piped and double-row-piped frozen soil walls. Further by using the coefficient of coverage，an analytical solution of three-row-piped frozen temperature field was also worked out. Comparison of the analytical solution with the numerical thermal analysis shows that the analytical solution is precise enough and will afford some new thoughts in working out the analytical solution of multi-row-piped frozen temperature field，as well as some reasonable guidance in three-row pipe freezing projects.

Keywords： soil mechanics artificial ground freezing three-row-piped freezing temperature field analytical solution potential function thermal-hydraulic analogy

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