



### 洪水中漂浮管道的应力分析

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### STRESS ANALYSIS OF PIPELINE FLOATING IN FLOOD

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**摘要** 洪水对管道构成严重威胁, 可能导致管道冲出、裸露甚至大范围漂浮。管道在动水作用力、浮力、重力及岸边土体抗力的共同作用下发生空间弯曲变形。建立洪水管道力学分析模型, 考虑管-土间非线性相互作用、管道轴力和管材非线性等因素, 推导了管道空间变形曲线方程和变形协调方程, 采用迭代方法求解管道的应力与应变。基于解析方法开发计算程序, 通过算例分析了不同管道参数、洪水参数条件下管道变形与应力-应变分布。建立各算例有限元模型, 对比分析表明解析方法计算结果与有限元方法吻合较好。基于极限状态理论提出洪水管道的安全评定方法, 并对案例管道进行了安全评定。

**关键词:** 管道 洪水 应力-应变 解析方法 空间弯曲变形 非线性

**Abstract:** River-crossing pipeline is threatened by flood which could induce the pipeline being eroded and exposed, moreover, floating in a large scale. Under the combined effects of dynamic water, buoyancy, gravity and resistance of bank soil, pipeline generally presents three-dimensional bending. A mechanical analysis model is built to investigate the mechanical behaviour of pipeline exposed in flood. Taking into account the nonlinear pipe-soil interaction, the axial force and material nonlinearity of pipeline steel, the dimensional bending curve and a deformation compatibility equation of pipeline are derived. And pipeline stress and strain are calculated with an iterative solving method. Based on the proposed analytical methodology, a computer program is developed and the pipeline deformation, stress and strain are analyzed through a series of examples. Each example is subsequently investigated with the finite element method and the calculation results of the proposed method are close to that of the finite element method. Finally, a safety assessment method for pipeline in flood is proposed according to limit state theory, by which the safety of a pipeline exposed in mountain torrent is assessed.

**Key words:** pipeline flood stress and strain analytical methodology dimensional bending nonlinear

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