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长距离顶管管道的失稳分析

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摘要 管道失稳是由于管道周围土体提供的抵抗力矩小于偏心顶推力而产生的扭转力矩，造成管节偏离设计轴线。分析了长距离直线顶管施工时管土之间的相互作用，认为管道在承受对角荷载时会产生转动力矩，当管道端部的最大土体反力超过土体承载力时土体产生破坏，造成管道整体失稳。提出了管道失稳时假定接头处为铰链的管土相互作用宏观模型。分析了传统曲线顶管施工中管土之间的相互作用，建立了首节管道和后续管节的受力模型及土体反力分布模式。采用考虑位移的土压力计算方法计算环向土压力，得出首节管道和后续管节最大土体反力的计算公式。对一个工程实例进行了计算，结果表明首节管道容易失稳。提出了长距离直线和曲线顶管施工防止管道失稳的控制措施。

关键词 土力学；顶管；管道失稳；土体反力；顶力

分类号

ANALYSIS OF STABILITY FAILURE FOR PIPELINE DURING LONG DISTANCE PIPE JACKING

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Abstract

When the resistive moment of surrounding soil is less than the torsional moment of eccentric jacking force，stability failure of pipeline occurs and pipes deviates from the designed axes. The reciprocal action between pipes and soil during long-distance linear pipe jacking is analyzed. It is considered that rotational moment arises when pipeline is diagonally loaded. When the maximal soil counterforce of tail pipeline exceeds its bearing capacity，soil fails and pipeline loses stability. The macroscopic model of pipe-soil interaction at failure of pipeline is put forward by assuming that the joints act as hinges. The pipe-soil interaction in the traditional curved pipe jacking is analyzed. The soil counterforce distribution model and load bearing model for the heading and the latter pipelines are set up. By considering displacement for calculating circular earth pressure，the maximal earth counterforce formulas for the heading and the latter pipelines are deduced. The calculation of an example shows that the heading pipeline is apt to lose stability. Finally，several control measures are proposed to avoid failure for long-distance linear and curvilinear pipe jacking construction.

Key words soil mechanics；pipe jacking；stability failure of pipeline；earth counterforce；jacking force

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