

土质边坡极限平衡状态及临界滑动面的判定方法

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DETERMINATION METHOD OF LIMIT EQUILIBRIUM STATE AND CRITICAL SLIP SURFACE OF SOIL SLOPE

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摘要

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摘要 开展边坡失稳判据及临界滑动面确定方法的理论与数值实现研究。应用分叉理论的研究成果,证明满足关联流动法则的理想弹塑性材料,在平面应力或平面应变条件下的失稳模式为应变局部化模式,由此类材料构成的边坡模型的失稳过程为局部带渐进扩展过程。基于以上证明,提出局部化带贯通判据,认为表征边坡整体失稳的充要条件是局部化带在边坡内部的完全贯通。基于数值模拟,发展一种局部化带路径追踪技术,根据每个增量时步土体单元的局部化状态信息,通过后处理显式追踪局部化带的形成、扩展、汇合直至贯通的过程,直观、方便地判断边坡的极限平衡状态,同时确定临界滑动面的位置。并开展强度折减和位移加载算例研究,验证局部化带贯通判据及数值实现方法的适用性。

关键词: [边坡工程](#) [边坡稳定性](#) [弹塑性模型](#) [分叉理论](#) [失稳判据](#) [临界滑动面](#)

Abstract: The present contribution is concerned with theoretical and numerical issues in finite element slope stability analysis. In the theoretical part, instability phenomena of slope material are studied within the framework of bifurcation theory. It is proved that strain localization not only is a ubiquitous feature of elastoplastic geomaterials, but also is the unique instability mode of the elastic-perfectly plastic material with an associative flow rule under plane strain and plane stress conditions. The shear band coalescence criterion is proposed, which argues that slope failure occurs when smaller size shear bands coalesce into a dominant shear band which completely divides the slope into two parts. In the numerical implementation part, a strategy for tracking the localization band path is presented. By tracking the initiation, growth and coalescence of localization zones in terms of the localized state of all soil elements at each time step, the limit equilibrium state can be directly judged; and the critical slip surface can be simultaneously determined. Finally, the feasibility and reliability of the proposed criterion are validated by strength reduction and over-loading examples.

Keywords: [slope engineering](#) [slope stability](#) [elastoplastic model](#) [bifurcation theory](#) [instability criterion](#) [critical slip surface](#)

引用本文:

刘晓宇, 赵颖, 刘洋, 李世海. 土质边坡极限平衡状态及临界滑动面的判定方法[J] 岩石力学与工程学报, 2012, V31(7): 1369-1378

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