

富水弱胶结砂岩地层围岩破坏机理与控制技术研究

Failure mechanism of water-rich weakly consolidated sandstone and classification control of coordinated support

康鑫^{1,2} 谢雄耀^{1,2}

Xin Kang^{1,2}Xiongyao Xie^{1,2}

(1. 同济大学土木工程防灾国家重点实验室, 上海 200092;

2. 土木工程学院地下建筑与工程系, 上海 200092)

(1. State Key Laboratory for Disaster Reduction in Civil Engineering, Tongji University, Shanghai 200092, China;

2. Department of Geotechnical Engineering, Tongji University, Shanghai 200092, China)

摘要: 随着“西部大开发”战略和“一带一路”倡议的深入实施,我国能源开发与基础设施建设逐渐向西部地区转移,今后地下工程施工过程中将会有越来越多工程遇到弱胶结砂岩地层。本文通过进行弱胶结砂岩不同围压不同含水率的三轴试验,定量分析了含水率与弱胶结砂岩力学参数间的相关关系,给出了弹性模量、峰值内摩擦角、峰值粘聚力、残余内摩擦角、残余粘聚力和膨胀角与含水率之间的关系式。为研究水对弱胶结砂岩地层围岩整体稳定性的影响机制,基于给出的关系式,结合有限差分原理,推导了考虑水弱化效应的弱胶结砂岩地层隧道开挖围岩阶段性破坏半解析解,结果表明从天然状态至饱水状态围岩参数逐渐劣化,切向应力峰值从 12.32MPa 减小为 11.51MPa,围岩位移从 0.14m 增加至 0.57m,揭示了围岩两阶段的分阶破坏现象。

关键词: 弱胶结砂岩; 富水; 三轴试验; 分阶段破坏

Abstract: With the in-depth implementation of the “Western development” strategy and the “Belt and Road” initiative, China's energy development and infrastructure construction are gradually transferred to the western region, and more and more projects will encounter weakly consolidated sandstone formation in the future underground engineering construction process. In this paper, the correlation between water content and mechanical parameters of weakly cemented sandstone is quantitatively analyzed through triaxial tests of different confining pressures and different water content, and the relationship between elastic modulus, peak internal friction Angle, peak cohesive force, residual internal friction Angle, residual cohesive force and expansion Angle and water content is given. In order to study the influence mechanism of water on the overall stability of surrounding rock of weakly consolidated sandstone formation, based on the given equation and combined with the finite difference principle, a semi-analytical solution of the phased failure of surrounding rock of weakly consolidated sandstone formation tunnel excavation considering water weakening effect was derived. The results show that surrounding rock parameters gradually deteriorated from natural state to water-saturated state. The peak value of tangential stress decreases from 12.32MPa to 11.51MPa, and the displacement of surrounding rock increases from 0.14m to 0.57m, which reveals the hierarchical failure phenomenon of surrounding rock in two stages.

Keywords: Weakly consolidated sandstone; Rich water; Triaxial test; Failure by stages