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开挖卸荷条件下大型地下硐室块体稳定性的对比分析

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摘要　运用FLAC3D软件对三峡地下电站主厂房的典型边墙和顶拱块体分别进行三维数值模拟分析，对比分析其模拟结果表明：(1) 边墙块体在水平垂直厂房轴线(x方向)和铅直(y)方向上应力均表现出卸荷特征，特别是x方向。其变形主要以向开挖区卸荷回弹变形为主；(2) 顶拱块体在x方向表现为压应力，其值随开挖逐渐增加，而y方向只是在开挖初期卸荷，但随后面的开挖有逐渐回升的趋势。其变形在x方向为挤压变形，y方向块体下部向下变形，而上部因挤压而表现出向上变形；(3) 大型地下硐室开挖过程中，块体的应力－形变场特征对顶拱块体稳定是有利的，而对边墙块体是不利的。因此，通常的极限平衡分析结果，对边墙块体是偏高的，而对顶拱块体是偏于保守；(4) 提出通过变形特征来定性判断块体整体稳定性和通过塑性区分布规律来定量评价块体的局部稳定性的方法。

关键词　岩石力学；卸荷；地下硐室；块体；应力；变形；稳定性；数值模拟

分类号

CONTRASTIVE ANALYSIS OF STABILITY OF BLOCK IN LARGE UNDERGROUND CAVERNS UNDER CONDITIONS OF EXCAVATION AND UNLOADING

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Abstract

3D numerical simulation of typical sidewall and crown blocks is carried out for underground powerhouse of the Three Gorges Project. The following results can be drawn. (1) The sidewall block is in unloading stress state in vertical direction(y-direction) and horizontally perpendicular to powerhouse axis(x-direction)，especially the latter and its main deformation is horizontally unloading rebound to excavated zone. (2) The compressive stress of the crown block is gradually increased in x-direction along with excavation，but the vertical stress is in unloading state in initial excavation stages and gradually increases along with latter excavation. Its main deformation is compressive in x-direction，but in y-direction，the lower part of block goes down because of unloading and the upper part goes up because of x-direction extrusion. (3) The stress-deformation field of blocks in process of excavation is beneficial to the stability of crown blocks，but unfavorable to the sidewall blocks. So，the calculation result based on rigid body limit equilibrium

theory is over-estimated to sidewall blocks，but conservative to crown blocks. (4) The authors present that the method of qualitatively judging block general stability by its deformation and of quantificationally evaluating local stability by plastic zone characteristics.

Key words rock mechanics；unloading；underground cavern；block；stress；deformation；stability；numerical simulation

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