# 不連續面先天異向性及應力異向性對岩石邊坡孔隙水壓分布之影響

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## 摘要

岩石邊坡受岩體中的不連續面影響，其所形成之複雜網絡往往是地下水之重要通道，因此不連續面之特性，包含位態、內寬等會影響岩石邊坡之滲透特性。根據前人研究發現不連續面位態分布會使岩體滲透係數產生先天異向性，同時應力會影響不連續面之內寬，亦將導致滲透係數產生應力引致異向性。本研究利用 FLAC3D 建立邊坡模型，利用擬連續體模式(continuum approach)考慮不連續面先天異向性以及岩體不連續面內寬隨正向應力改變之應力引致異向性計算等值滲透係數張量(equivalent permeability tensor)，將計算結果輸入模型，透過滲流分析得到穩態孔隙水壓於邊坡模型之分佈情形，最後再進行邊坡穩定分析得到安全係數與剪應變增量區。

當只比較均向應力場及非均向應力場的影響，於岩石邊坡孔隙水壓最大相對差異值約 21%，但對安全係數及剪應變增量區並無顯著影響；而加入考慮不連續面異向性程度於均向應力場的影響，當走向節理數量明顯多於傾向節理時，孔隙水壓最大相對差異值約 52%分佈於坡趾處，安全係數隨之減小；此外，考慮不連續面異向性程度於非均向應力場的影響，同樣的情況下孔隙水壓最大相對差異值約 51%，安全係數卻隨之增加。結果顯示，在本研究情況假設下，不連續面異向性程度會影響孔隙水壓分佈進而減低邊坡穩定性，但是應力場也同時會影響孔隙水壓的分佈，若忽略應力引致之滲透係數異向性，將會低估安全係數的值。因此，針對岩石邊坡進行穩定性分析時需考慮不連續面特性對地下水流動的影響。

**關鍵字：**岩石邊坡穩定分析、擬連續體模式、FLAC3D、滲透係數異向性。

# The effects of inherent distribution of discontinuities and stress-induced anisotropy on pore water pressure distribution of rock slopes

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## Abstract

The complex of fracture networks are major flow paths in rock slopes. Therefore, the geometry of the discontinuities including orientation and aperture, will affect the distribution of pore water pressure in rock slopes. According to a previous study, it indicated that the orientation of discontinuities in a rock mass would lead to the inherent anisotropy of permeability. In addition to the results of that, the stress also made the aperture change leading to the stress-induced anisotropy. This research uses FLAC3D to establish the rock slope model with simple geometry, considering the inherent distribution of discontinuities and stress-induced anisotropy to calculate the equivalent permeability tensor by continuum approach. Finally, the results of the equivalent permeability tensor will be input into the model and then the steady-state pore water pressure distribution will be calculated by fluid-flow analysis.

When only considering the result by comparing the influence under a uniform stress field and non-uniform stress field, the maximum relatively pore water pressure variation is 21%. This is no significant influence for the factor of safety and shear strain increment zone on rock slopes. Secondly, the influences of different anisotropic levels of discontinuities under a uniform stress field was analyzed. The results showed that when the number of strike joints are significantly more than dip joints, the pore water pressure maximum variation is 51%, which decreases the factor of safety. However, discussing the same situation under a non-uniform stress field, the factor of safety increases. Therefore, without considering the stress-induced anisotropy under this situation, we will under-estimate the factor of safety. As a result, the rock slope stability analysis needs to consider the impact on the properties of discontinuities.

**Keyword:** Rock slope stability、Continuum approach、FLAC3D、anisotropic permeability.