不連續面引致滲透係數異向性對邊坡之影響

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摘要

在邊坡上常常會受岩石中的不連續面影響其穩定性，且不連續面通常是地下水通道，然而不連續面密度、長度、內寬、位態等特性會影響岩石的滲透係數，據前人研究將不連續面的幾何排列型態用組構張量(Fabric Tensor)表示，並計算相應的滲透張量(Permeability Tensor)，若組構張量主方向與滲透張量主方向一致時，會使不連續面內寬改變並導致滲透係數異向性。本研究透過數值軟體 FLAC3D 建立簡單邊坡模型，並將前人使用 Fortran 編譯型程式語言，以計算相應的滲透張量所建立的程式碼，轉換成可在 FLAC3D 內直接使用的 Fish 直譯式程式語言相關程式碼， 將所有計算在 FLAC3D 中完成，接著經由滲流分析得到穩態孔隙水壓在邊坡模型的分佈情況，再根據孔隙水壓分佈結果進行剪力強度折減分析計算得到邊坡安全係數與其剪應變增量區。

當組構張量的 Z 方向數值越大時，其異向性指數也會隨之增大並有線性關係，且組構張量的 Z 方向數值 0～4 時，孔隙水壓與總水頭會隨深度增加而上升；組構張量的 Z 方向數值在 5 以上時，孔隙水壓與總水頭會急遽增加並保持穩定。

關鍵字： 異向性、組構張量、滲透係數、FLAC3D

The effects of discontinuity-induced anisotropy of permeability on rock slope

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Abstract

On the slope, the stability of the discontinuities in the rocks is often affected, and the discontinuities are usually groundwater channels. However, the characteristics of discontinuity like density, length, aperture, and orientation affect the permeability of rocks, and according to previous studies, the geometric arrangement of discontinuities is expressed by fabric tensor and calculate the permeability tensor. If the principal direction of the fabric tensor is consistent with the principal direction of the permeability tensor, the aperture of the discontinuities are changed, and the permeability become anisotropic permeability. This research uses FLAC3D to establish the simple rock slope model, and the code by the predecessors using the Fortran compiled language to calculate the permeability tensor is translate the code of the Fish interpreted language that can be used in FLAC3D, and all the calculations are completed in FLAC3D. Then the steady-state pore water pressure distribution is calculated by fluid-flow analysis and then calculate the factor of safety by the slope stability analysis and show the shear strain increment.

The results indicate a linear relationship between the Z-direction fabric tensor value and the anisotropy index: a higher Z-value means a higher anisotropy index. When the Z-value is between 0 and 4, pore water pressure and total head increase with depth. However, when the Z-value is greater than 5, pore water pressure and total head rises quickly and stays stable.

Keywords: Anisotropy, Fabric tensor , Permeability, FLAC3D.