岩層弱面深度差異性對岩石邊坡穩定性之影響以國立陽明交通大學場址為例

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摘要

本研究透過數值軟體 FLAC^{3D} 將國立陽明交通大學地區根據前人所繪製的 A-A’ 地質剖面(Alvian,2023)模型化，並根據不同不連續面分佈方式的邊坡模型進行一系列的數值模擬，包含不連續面的位置、延續性、傾角方向等，同時考慮邊坡模型內穩態孔隙水壓分佈，再根據孔隙水壓分佈結果進行剪力強度折減分析計算邊坡安全係數，並討論在不同地質條件下邊坡是否發生破壞、滑動及若發生滑動時其影響範圍。本研究以遍布節理模式(Ubiquitous-Joint Model)建立模型將分為以下 3 種不同地質條件進行數值模擬：情境 1，地質條件包含走向節理與 L2(砂岩頁岩互層)-L3(砂岩層)間層面；情境 2，地質條件包含走向節理與 L3(砂岩層)平行層面裂隙；情境 3，地質條件包含走向節理與 L4(砂岩頁岩互層)不連續面，而此次研究主要以情境 1、情境 3 的地質條件進行模擬分析。研究結果表示在不同地質條件下岩石邊坡的孔隙水壓皆會隨地形深度遞增，然而在情境 1 地質條件下在 L2-L3 間層面有明顯的最大剪應變增量;在情境 3 地質條件下在上部 L4 不連續面有明顯的最大剪應變增量，當最大剪應變增量數值越大，可能先從數值越大的範圍形成破壞。本研究在走向節理的摩擦角參數在未來試驗後會取得，且會比目前所得參數都大，所以安全係數會再上升，且之後會完成情境 2 之相關分析。

關鍵字:地質模型、邊坡穩定分析、遍布節理模式、FLAC^{3D}

The impact of variation in the depth of weak plane in rock layers on the stability of rock slopes: A case study of the site at National Yang Ming Chiao Tung University

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Abstract

This study uses FLAC^{3D} to model the area surrounding National Yang Ming Chiao Tung University based on the A-A' geological profile drawn by previous research (Alvian, 2023). A series of numerical simulations were conducted on slope models with different distributions of discontinuities, including the position, continuity, and dip direction. At the same time, the steady-state pore pressure distribution within the slope models was considered. Based on the pore pressure distribution results, a shear strength reduction analysis was carried out to calculate the slope safety factor. The study also discusses whether slope failure or sliding occurs under different geological conditions and the potential impact range if sliding occurs. The slope models were built using the Ubiquitous-Joint Model and simulated under three different geological conditions: Scenario 1 includes strike joints and the interface between L2 (Shale intercalated with occasional sandstone) and L3 (sandstone); Scenario 2 includes strike joints and parallel bedding fractures within L3 (sandstone); and Scenario 3 involves strike joints and discontinuities in L4 (Sandstone intercalated with occasional shale). This study mainly focuses on analyzing the geological conditions of Scenario 1 and Scenario 3. The research results show that under different geological conditions, the pore water pressure in rock slopes increases with depth. However, in Scenario 1, the maximum shear strain increment is observed at the L2-L3 interface. In Scenario 3, the maximum shear strain increment is observed at the upper L4 discontinuity. The larger the maximum shear strain increment, the more likely failure will occur in areas with higher values. The friction angle of the strike joints will be obtained through future testing and is expected to be greater than the current value, which will increase the safety factor. Furthermore, the analysis related to Scenario 2 will be completed in the future.

Keywords: Geological modeling, Slope stability analysis, Ubiquitous-Joint Model, FLAC^{3D}.