滲透率和強度異向性在降雨滲透下對弱膠結岩石邊坡穩定性的影響

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報告者：劉佳怡
指導教授：董家鈞 老師
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摘要

具有明顯分層的弱膠結岩石邊坡具有滲透率和強度異向性，進而影響地下孔隙水壓之分佈及邊坡穩定性，而其異向性取決於層理面之位態。因此，本研究建立三維數值模型評估了降雨入滲下地下水位之變化，模擬降雨前後邊坡的地下水位和孔隙水壓力，計算出對應於初始和最高地下水位的孔隙水壓力用於邊坡穩定性分析，並且進一步分析不同層理位態對邊坡穩定性之影響。結果表明，與具有較緩傾角之層理面相比，具有陡峭層理面的邊坡地下水位上升幅度更大和其孔隙水壓力增加幅度更大，進而導致安全係數下降幅度較大，此外，其地下水位上升和各深度達到最大孔隙水壓力的所需時間更短。考慮到層面位態造成之異向性和降雨期間地下水位的上升行為，此研究進一步提出四種具有不利條件之邊坡：即(1)層理面的位態與坡面相同(cataclinal dip slopes)，(2)層理面的走向與坡面相同，但其傾角小於坡面(cataclinal under-dip slopes)，(3)層理面的走向與坡面相同，但其傾角大於坡面 (cataclinal over-dip slopes) ，以及(4)層理面的走向與坡面夾 180°，但其傾角大於坡面(anaclinal slopes)。這些具有不利條件之邊坡是山崩潛勢分析中影響預測結果之因素，為了確保安全的土地開發，此四種狀況需謹慎分析和討論。

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3D Effects of permeability and strength anisotropy on the stability of weakly cemented rock slopes subjected to rainfall infiltration

Po-Tsun Yeh[a], Kevin Zeh-Zon Lee[b], Kuang-Tsung Chang[a,*]

[a] Department of Soil and Water Conservation, National Chung Hsing University, Taichung 402, Taiwan
[b] U.S. Bureau of Reclamation, Denver, CO 80225, USA

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ABSTRACT

Weakly cemented sedimentary rocks with pronounced stratification exhibit permeability and strength anisotropy. The influence of permeability and strength anisotropy on the groundwater flow and slope stability depends on the orientation of the bedding planes. The stability of slopes with different orientations of bedding planes under rainfall infiltration was evaluated in this study using three-dimensional finite element modeling. The groundwater table and pore water pressure in slopes before and after rainfall were simulated, and the calculated pore pressure corresponding to the initial and highest groundwater tables was used for slope stability analyses. The results showed that in comparison with gently dipping bedding planes, a slope with steeply dipping bedding planes exhibits a greater rise of the groundwater table and a greater increase of pore pressure, leading to a larger reduction in the factor of safety. Also, a shorter time is required to reach the highest groundwater table and the maximum pore pressure at a certain position. In consideration of the anisotropic behavior and the groundwater table rise during rainfall, unfavorable conditions were identified for the slope stability. The four unfavorable conditions, where the bedding planes and the slope face approximately strike in the same direction are: (1) the daylight condition of the bedding planes, (2) the coincidence of the bedding planes and the slope face, and (3) steep bedding planes dipping out or (4) into the slope. Slopes with the unfavorable orientations of bedding planes need additional attention in order to ensure a safe land development in the mountainous areas.