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降雨滲透對邊坡穩定影響之研究
Effects of Rainfall Infiltration on Slope Stability

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中文摘要

臺灣地區由於地形、地質、氣象、水文等自然條件欠佳，山坡地發生地層滑動情形原本就較爲頻繁，再加以近年來山坡地利用之急速增加，諸多位於敏感區域之大量開發行逕，均可能會釀成坡地之土石災害，而對人民的生命財產造成無法彌補之損傷。因此對地層滑動相關問題之研究，對國家社會的繁榮發展與人民之生存保障，不諦是極其重要的。

然而造成地滑的原因頗爲地錯綜複雜，除了不良的地質或岩層結構條件外，水文、水理上的特性亦爲誘發地滑之重要因素。其中多數的地滑均係受到雨水之大量滲透而引起地下水的升高所誘發。爲能瞭解降雨滲透對地下水與邊坡破壞間之機制關係，本文乃就對此間之關係進行探究，藉由現場之試驗與監測所得資料，以檢視其間之相互關係，並依據土壤力學與坡地水文學之原理，探討降雨之滲透特性、土壤水份傳輸移動與飽和地下水之側向流動情形等，進而建立邊坡因降雨滲透影響而所發生滑動之模式。

研究結果顯示，造成本試驗地邊坡產生滑動破壞的原因，除受雨水漫流滲透之影響使土層軟化並使地下水位升高降低抗剪強度外，坑溝之侵蝕作用而使坡趾淘刷，並失去平衡支撐亦爲最重要的肇因。而由降雨量與土壤之初期水份含量言，其對地中應變量（大地應力）、地下水位與雨水滲透速率等均有相當大的影響。就地中應變量而言，降雨量越大則其波動幅度亦越大，且其影響時間則根據土壤之初期水份狀態不同則可達數天至數十天之久。降雨滲透對地下水位影響之稽延時間，根據乾、濕季之不同而有數小時至一、二天之差距，而其消退期通常爲三、四天。當乾旱季節時地下水位與土壤初期水份含量較低，降雨滲透至影響地下水位之反應時間較長，且其反應幅度較小；

當濕潤季節時其地下水位與土壤初期水份含量較高，故降雨對其影響較速，而反應之幅度也較大。雨水之滲透隨其滲入深度之增加，而土壤水份含量反應之幅度變小，則其稽延時間越長；反之滲入深度越淺，則其反應之幅度越大，而稽延時間則越短。

同時本研究導入試驗調查之網格區劃密度分析，以容許之信賴限界值與相對誤差值爲基準，計算適宜之區劃網格大小，進行採樣試驗分析。並將雨水之滲透過程以未飽和之垂直水份傳輸移動與飽和側向流動模式加以分段組合模擬，而應用於實際邊坡之穩定性分析評估，所得結果與觀測資料趨勢相當吻合，或可對其稽延特性提出合理之解釋。

ABSTRACT

Taiwan, located in the mobile belt of the eastern side of Asia, is highly susceptible to hillslope movements as a result of contributing factors such as topography, geology, earthquate, typhoon and heavy rainfall. In recent years, hillslope landuse changes and development activities often increase the severity of sediment related disasters, resulting in great loss of properties and lives. Consequently, in-depth studies on landslide mechanisms and protection measures are very important research topics.

However, factors contributing to landslides are complex. These include weak stratum structure and the abnormal hydrologic and hydraulic conditions. Majority of landslides are caused by raised groundwater table due to great amount of precipitation. The purpose of this study was to investigate rainfall infiltration and groundwater table changes on slope stability with data from field observations and theoretical analyses based on the principle of soil mechanics and hillslope hydrology. The results will help understand the influences on slope stability by characteristic of rainfall infiltration, groundwater table raising, as well as movement of soil water and groundwater.

The study results show that in addition to the undercutting of slope by gully and headward erosion, reduced soil strength due to high groundwater table by rainfall

infiltrationcan result in the slope sliding. The strain magnitude (the earth stress), groundwater table and soil hydraulic conductivity are significantly affected by the precipitation and antcedent soil water content. The response range of underground strain magnitude is positively related to the increasing precipitation. This responses generally occur several days later, depending on antcedent soil water content. Groundwater table rising have a lag time of about several hours to one or two days and the recession times are about three or four days. The response range of decreased soil water content and increased lag time are dependent on depth in the soil profile.

Statistical method is used to determine the sampling size by allowing index values of confident limit and relative error. The combined use of infiltration model and saturate-unsaturate soil water transporation model for the slope stability evaluation give results that closely conform with field observations.