

## 山區道路均質及異質邊坡背拉式擋土排樁之穩定性參數研究

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**摘要** 本研究首先針對林務局羅東林區管理處 2012 年度宜專一線地滑區與背拉式地錨擋土排樁(以下簡稱背拉式擋土排樁)之監測結果,進行三維有限元素數值分析。同時,設置兩組虛擬邊坡,即崩積層-均質邊坡及崩積層/岩層-異質邊坡之典型模型邊坡,進行排樁及地錨之設計參數研究。在數值模型中,選用上、下邊坡之坡度( $\alpha_u=30^\circ$ ,  $\alpha_d=40^\circ$ ),地錨不同錨碇段長度  $L_g$  及地錨傾角  $\theta$ ,以及排樁打設間距比  $S/D$  等參數,探討其對邊坡穩定性及排樁結構力學行為之影響。最後,可歸納出背拉式擋土排樁穩定邊坡中,所採用排樁及地錨設計參數之最佳化配置原則。依據分析成果可知,排樁在崩積層/岩層-異質邊坡之穩定性安全係數  $FS$ ,皆高於崩積層-均質邊坡者,此說明排樁設計時,樁尖貫入岩層(承載層)之重要性。當排樁打設間距比  $S/D=6\rightarrow 8$  時, $FS$  幾無變化;但當  $S/D=8\rightarrow 10$  時, $FS$  會明顯降低。由此可推論,排樁打設間距超過 8 倍樁徑後,排樁間之土拱效應將消失。再者,當地錨之錨碇段長度由  $5\rightarrow 7$  m 時,崩積層-均質邊坡之  $FS$  明顯上升,而崩積層/岩層-異質邊坡之  $FS$  則微幅提升;而錨碇段長度由  $7\rightarrow 10$  m 時,兩者之  $FS$  皆趨於定值。由此可推論,採用地錨之錨碇段長度 7 m 為較合適之設計參考尺寸。

**關鍵詞**: 三維有限元素數值分析、背拉式擋土排樁、錨碇段長度、穩定性安全係數。

## Parametric Studies on the Stability of Tied-Back Retaining Piles Installed in the Homogeneous and Heterogeneous Cut Slope of Mountainous Road

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**ABSTRACT** Firstly, this study performed a series of three-dimensional (3-D) finite element analyses to investigate the stability and stabilization mechanism of tie-back retaining pile of landslide at Yi-Zhuan No. 1 forest road (or Yi-Zhuan-No.1 Landslide) using monitoring data of tie-back anchors. Meanwhile, two groups of fictitious model slopes, namely, homogeneous slope of colluviums (or homogeneous slope) and heterogeneous slope of colluviums on bedrock (or heterogeneous slope), were established to carry out a systematic numerical experiment on various design parameters (or numerical variables) of tie-back retaining pile. In numerical experiments, the design parameters consist of inclination angle of up and down slopes ( $\alpha_u=30^\circ$ ,  $\alpha_d=40^\circ$ ), the anchorage length ( $L_g$ ), inclination ( $\theta$ ) and spacing ratio ( $S/D$  =pile spacing/pile diameter) of retaining pile. The effects of design parameters on the slope stability and mechanical behaviors of tie-back retaining pile were also detected. Finally, based on the numerical experiments, the optimal configuration of design parameters for the stability and stabilization mechanism of tied-back anchor retaining pile can be drawn. For a fictitious slope, the  $FS$  value of heterogeneous slope (colluviums on bedrock) is always higher than that of homogeneous slope (colluviums) and this shows the importance in the design to penetrate the retaining pile into the bedrock (bearing stratum). Moreover, the  $FS$  value turns into greatly decrease as the installation spacing  $S$  value larger than  $8D$  ( $S \geq 8D$ ) and this indicates that the arching effect between two adjacent piles immediately disappears when the spacing of piles is larger than 8 times of pile diameter. In addition, the  $FS$  value of homogeneous slope is greatly promoted when the anchorage length  $L_g$  increase from 5 to 7 m while it is not the case for heterogeneous slope the increase is very rare. However, the  $FS$  values of the two types of fictitious slopes, become unchanged and tend to be a constant when the  $L_g$  value increases from 7 to 10 m. Accordingly, it can be concluded that an anchorage length of 7 m can be adopted appropriately in the design of tie-back retaining pile.

**Key Words** : Three-dimensional (3-D) finite element analyses, Tied-back retaining pile, Stabilization works, Anchorage length, Factor safety of slope stability.

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