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Determining Ground Water Table in Slopes with Horizontal Drains and Design Framework for Length and Spacing

S.O.A.D. Mihira Lakruwan, Akiyoshi Kamura, Motoki Kazama

APPENDIX C

Factor of Safety Enhancement by Porewater Force Reduction

The reduction in the *U* by HDs increases the effective stress (*N′*), which in turn increases the frictional resistance acting on the failure wedge enhancing the stability. Therefore, the method for using the *ΔU* to predict the *ΔFS* is discussed in this section.

According to the method of slices (Figure 9), the FS of the slope before applying the HDs can be defined as:

$$\mathrm{FS} = \frac{\sum_{i=1}^{n}[(W_i\cos\alpha_i - u_i)\tan\varphi' + c'\Delta x_i\sec\alpha_i]}{\sum_{i=1}^{n} W_i\sin\alpha_i} \quad (A.1)$$

where c' and Φ' denotes the effective cohesion (kN/m) and effective friction angle of the slip surface material, respectively, W_i is the weight of the slice (kN/m), u_i symbolizes the PWP on the slice (kN/ m), and Δx_i is the slice width.

Let the resultant PWP force reduction on a slice and FS increment by applying HDs equal to Δu_i (kN/m) and *ΔFS*, respectively.

$$\mathrm{FS} + \Delta\mathrm{FS} = \frac{\sum_{i=1}^{n}[(W_i\cos\alpha_i - (u_i - \Delta u_i))\tan\varphi' + c'\Delta x_i\sec\alpha_i]}{\sum_{i=1}^{n} W_i\sin\alpha_i} \quad (A.2)$$

From Equations (28) and (29)

$$\Delta\mathrm{FS} = \frac{\sum_{i=1}^{n}\Delta u_i\tan\varphi'}{\sum_{i=1}^{n} W_i\sin\alpha_i} \quad (A.3)$$

The total PWP force reduction on the slip surface (*ΔU* (kN/m)) can be defined as,

$$\Delta U = \sum_{i=1}^{n}\Delta u_i = \sum_{i=1}^{n}\left(u_{i(0)} - u_{i(HD)}\right) \quad (A.4)$$

Where $\Delta u_{i(0)}$ is the initial porewater force and $\Delta u_{i(HD)}$ is the porewater force resultant by HDs on a slice. Then,

$$\Delta FS = \frac{\Delta U\tan\varphi'}{\sum_{i=1}^{n} W_i\sin\alpha_i} \quad (A.5)$$

Accordingly, the reduction in the PWP force acting on a slip surface by HDs demonstrates the amount of FS increment that can be achieved.