Slope Stability Analysis at Ban Pa Hung, Pa Hung Subdistrict, Phan District, Chiang Rai Province

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Abstract

Landslides pose significant risks to human life and property in Ban Pa Hung Subdistrict, Phan District, Chiang Rai Province of Thailand, due to its location along hillside slopes and foothill regions. The area's varying soil types and geological characteristics result in differential landslide susceptibility across locations. This study investigated the engineering properties of local soils to assess slope stability. Soil characterization revealed dark brown sand-clay mixtures with well-graded grain size distribution, low permeability, and low plasticity index. Slope stability analysis was conducted using Bishop's simplified method of slices implemented through the KUslope 2.1 program. The calculated factor of safety, defined as the ratio of allowable stress to actual stress, exceeded 1.0, indicating that the slopes in Ban Pa Hung are currently stable with a low probability of landslide occurrence.

Objectives

To assess landslide risk and study the engineering properties of soil layers for slope stability analysis in Ban Pa Hung, Pa Hung Subdistrict, Phan District, Chiang Rai Province.

Methodology

- **Collect data in the field**
  - Characteristics of the soil
  - Permeability test
- **Laboratory tests**
  - Sieve test and classification based on the Unified Soil Classification System (USCS)
  - Atterberg's limits
  - Moisture content
  - Unit weight
  - direct shear test
- **Slope stability analysis**

Results

The soil in the study area consists of reddish-brown sand with well-graded particle distribution, ranging from fine sand to coarse sand, with some organic matter mixed in. Permeability testing at a depth of 2.0 meters revealed an average permeability coefficient of 1.07×10^{-3} cm/s, indicating very low drainage capability. Laboratory tests showed that the liquid limit ranged from 35.46% to 39.19%, the plastic limit ranged from 28.08% to 29.76%, and the plasticity index was between 6.98 and 10.17. Based on these characteristics, the soil is classified as sandy clay. Shear strength testing of the soil samples indicated an average cohesion of 16.5 tons per cubic meter and an average internal friction angle of 21.0 degrees.

Fig 1. Soil in study area

Fig 2. Study area at Ban Pa Hung Subdistrict, Phan District, Chiang Rai Province

Results

The slope stability assessment begins with calculating the Factor of Safety (F.S.), a numerical value that indicates whether the slope has high or low stability. Bishop's Simplified Method of Slices (Bishop, 1955) is used to calculate the factor of safety. This study analyzes slope stability using the KUslope 2.1 program.

$$\text{Factor of safety} = \frac{\text{Shear strenght}}{\text{Shear stress}}$$

Table 1. The Factor of Safety at different levels of water saturation.

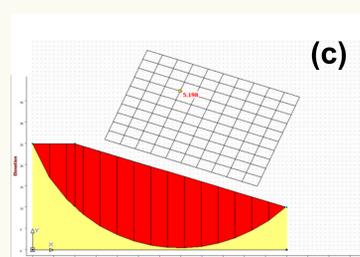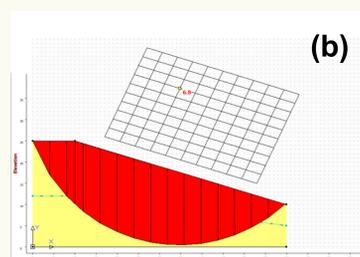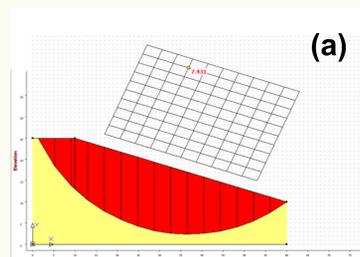| Sample	Degree of Saturation (%)	Factor of safety
1	0	7.431
	50	6.800
	100	5.198
2	0	9.788
	50	9.354
	100	8.359

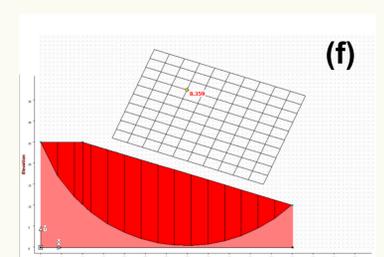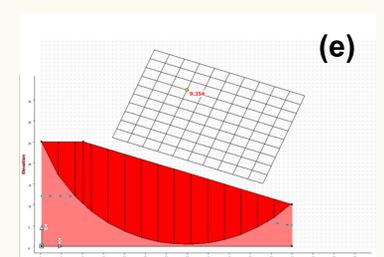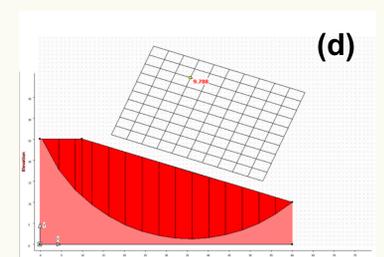Fig 3. The Factor of Safety for Sample 1 at (a) 0%, (b) 50%, (c) 100% water saturation

Fig 4. The Factor of Safety for Sample 2 at (d) 0%, (e) 50%, (f) 100% water saturation

Conclusion

The analysis of the Factor of Safety using Bishop's Simplified Method of Slices, conducted with the KUslope 2.1 program, revealed a Factor of Safety exceeding 1.0. This indicates that the study area has high stability and a low likelihood of landslides.

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