



Soil Testing at Pura Luhur Puncak Les in the Traditional Village of Angseri, Tabanan, Bali

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Abstract. Soil testing was carried out at Pura Luhur Puncak Les, located in the Traditional Village of Angseri, Baturiti Sub-district, Tabanan Regency, Bali Province. In terms of its geographical location, the temple is situated in a hilly area at an elevation of approximately 700–900 metres above sea level, with a slope gradient of around 15–35 per cent and high rainfall (>2.500 mm/year), which increases the susceptibility to erosion and the potential for landslides. The vulnerability of the slopes and soil structure around the temple area poses a potential risk of landslides, endangering visitors and the sacred buildings. The spatial planning and service facilities within the temple area are not yet optimal, thereby reducing comfort, safety and the quality of religious services. These conditions require intervention, namely the construction of a retaining wall, which necessitates comprehensive soil testing. The slope's vulnerability and the lack of a geotechnical basis for landslide risk mitigation were addressed using the Comprehensive Soil Investigation and Testing method and Data-Based Slope Stability Analysis. Soil samples for laboratory testing were taken from the slope where the retaining wall is to be constructed. The results of the soil testing concluded that the soil layer at the foot of the slope consists of rock; consequently, the soil's bearing capacity is believed to be very good. In planning, the soil bearing capacity can be assumed to be SPT = 50 or soil bearing capacity = 6 kg/cm².

Keywords: Soil Testing, Soil Bearing Capacity, SPT

1 Introduction

Landslides are one of the most common geotechnical problems in tropical regions with hilly topography and high rainfall, including Indonesia. These conditions are exacerbated by soil characteristics resulting from the weathering of volcanic rock, fairly steep slopes, and inadequate drainage systems. Therefore, a comprehensive investigation of soil conditions is a critical step before undertaking construction or land development in areas prone to landslides. Soil bearing capacity is the ability of the soil to support the load of a structure without experiencing excessive settlement (Sudiro, 2023).

The presence of numerous temples built in hilly areas makes infrastructure safety and slope stability critical factors in ensuring the sustainability of these areas. One such

area is Pura Luhur Puncak Les, located in the traditional village of Angseri, Baturiti Subdistrict, Tabanan Regency, Bali Province. The temple complex is situated at an elevation of approximately 700–900 meters above sea level, with slope gradients ranging from 15–35% and annual rainfall exceeding 2,500 mm. These conditions make the area highly vulnerable to surface erosion and landslides (see Figure 1).

Field observations revealed several early signs of slope instability, such as soil cracks, ground subsidence at several locations, and the formation of erosion channels caused by rainwater runoff. The main problem faced by our partners is the lack of accurate geotechnical data to serve as a basis for technical planning for the construction of retaining walls and the development of the temple complex. The soil investigations commonly used in Indonesia for foundation design are the Cone Penetration Test (CPT) and the Standard Penetration Test (SPT) (Rahim, 2025). The Cone Penetration Test (CPT) is very useful as a soil investigation tool because it provides important information for ensuring the safety of foundation designs in various soil layers, as well as from an economic standpoint (Sarah, 2025). Soil testing through field investigations and laboratory testing is one approach that can provide comprehensive technical information on the physical and mechanical characteristics of soil.



Figure 1. Site Location of Pura Luhur Puncak Les

Given these conditions, this community service activity was carried out through soil testing at the Pura Luhur Puncak Les site as an effort to provide accurate geotechnical data to support the planning of retaining walls and the sustainable development of the temple complex. The results of this community service initiative can be further utilized for planning drawings and preparing cost estimates for subsequent community service activities, thereby resolving the issues faced by our partners (Wahyudi et al., 2023).

2 Methodology

One way to test the strength of a soil layer is to use a Cone Penetration Test (CPT) or soil probe (Gazali et al., 2023). Data collection was conducted using the *Sondir* method. *Sondir* is a method designed to determine and test the strength of soil layers (Bela & Sianto, 2022). Soil testing is necessary to provide recommendations for an optimal foundation that ensures the safety and sustainability of the building (Buyang & Ayal,

2024). The cone penetration tester (Figure 2 and Figure 3) is a static penetrometer widely used in Indonesia. This device originated in the Netherlands and is known as the Dutch-Cone Penetrometer Test. The cone penetration test (CPT) is conducted using a lightweight cone penetration tester capable of withstanding loads of up to 2.5 metric tons (Putri & Triarso, 2024). The operating principle of this instrument is to press the tip of the penetrometer (cone) downward using a pressing mechanism anchored to the ground, and then record the cone penetration resistance and the soil's cohesion. Cone penetration resistance is the soil's resistance to the cone tip, expressed as force per unit area. Adhesion resistance is the soil's shear resistance against the biconical sleeve, expressed as force per unit length. There are two types of penetrometer tips commonly used: the cone (standard type) and the bicone (friction sleeve or adhesion jacket type). The cone is a cone with a 60-degree angle and a cross-sectional area of 10 cm², mounted on a series of inner rods and a sounding pipe. An important value measured from the sounding test is the cone tip resistance (q_c) (Rahim, 2024). In the standard method, the measurement results consist solely of the cone penetration resistance (cone value). This is obtained by applying pressure only to the inner rod. The force required to push the cone tip is measured using a pressure gauge attached to the penetration testing machine. Measurements are taken at specific predetermined depths, typically every 20 cm. After a measurement at a given depth is taken, the sounding pipe is advanced to the next depth, and the next measurement is taken by applying pressure to the inner rod, with the required force measured by reading the pressure gauge.

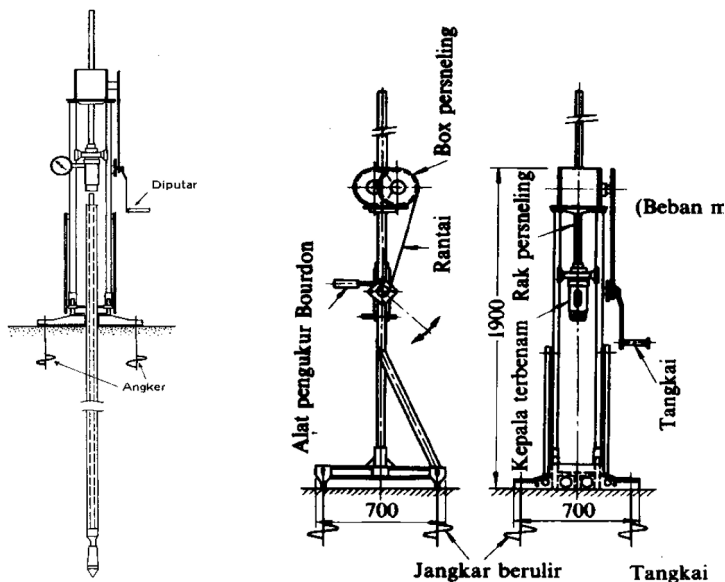


Figure 2. (a) Dutch Cone Penetrometer Diagram, (b) Dimensions of Soil Penetrometer Apparatus (in Indonesian Language)

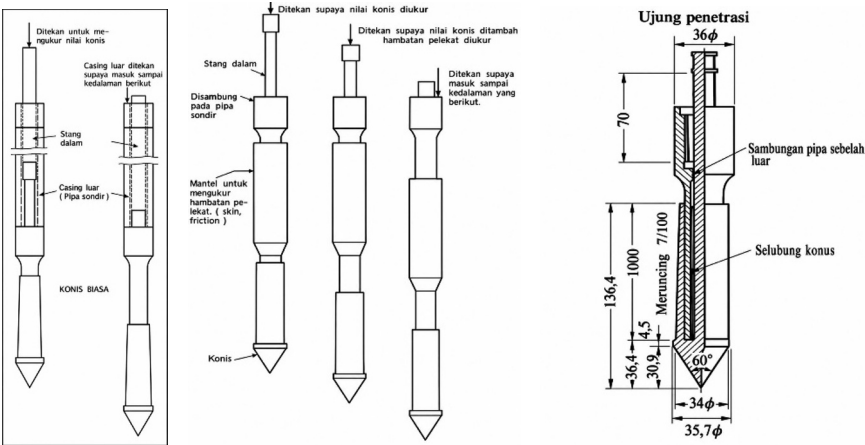


Figure 3. (a) Mechanical Cone Penetrometer Tip, (b) Friction Sleeve Operation (Bicone), (c) Dimensional Specifications of the Friction Sleeve (in Indonesian Language)

3 Result and Discussion

3.1 Result

The results of the cone penetration test indicate the soil's bearing capacity (Hutagalung & Silitonga, 2023). Field soil investigations using the cone penetration test (CPT) method are presented in tables and graphs with explanations. The CPT test results consist of the cone values at each 0.2-meter increase in depth and the average cone value at a specific depth. Elevation 0.00 is calculated from the local elevation at the test point. The cone penetration test data shown in the Table 1, Figure 4, Figure 5, and Figure 6 refer to the elevation of the local test point. Cone penetration tests are conducted until a cone reading of 250 kg/cm² is obtained. In addition to the cone values, this test can also determine the soil friction or cohesion values.

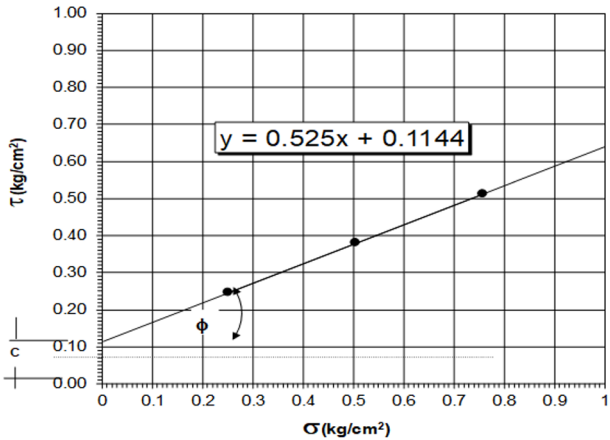
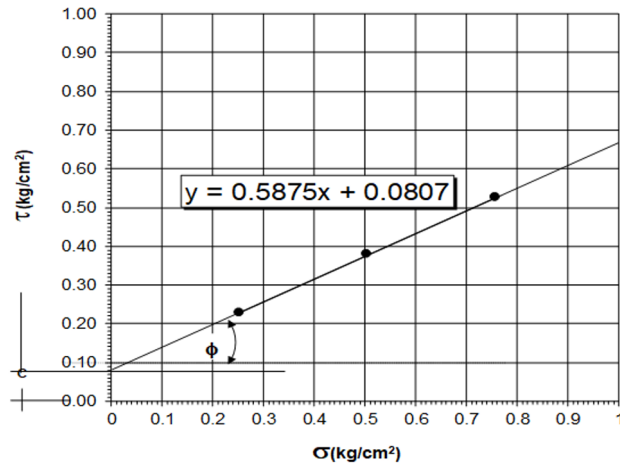
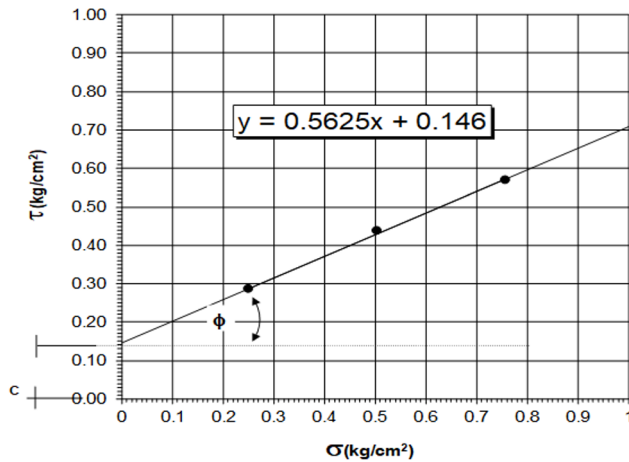


Figure 4. Direct Shear Test Specimen 1**Figure 5.** Direct Shear Test Specimen 2**Figure 6.** Direct Shear Test Specimen 3**Table 1.** Summary of Laboratory Test Results

Drilling Point	Sample Depth (m)	Physical Properties			Shear Parameters	
		Moisture Content ϕ (%)	Unit Weight γ (gr/cm ³)	Specific Gravity G_s	Cohesion c (gr/cm ²)	Angle of Shear Θ (deg)
B1	1	51.76	1.512	2.580	0.114	27.699
B2	1	59.74	1.601	2.576	0.081	30.434
B3	1.5	52.53	1.658	2.351	0.146	29.358
Average		54.68	1.59	2.50	0.11	29.16

3.2 Discussion

Samples for laboratory testing were collected from the slope where the retaining wall is to be constructed. The parameters tested in the laboratory were for the purpose of planning the external stability of the retaining wall. Testing at the base of the slope for the retaining wall foundation design was not performed due to equipment transportation constraints. Furthermore, the soil layer at the base of the slope consists of rock, so the soil bearing capacity is believed to be very good. In the soil bearing capacity design, an SPT value of 50 or a soil bearing capacity of 6 kg/cm² can be assumed.

4 Conclusion

Based on the test results, the average moisture content was 54.68%, the bulk density was 1.59 g/cm³, the specific gravity was 2.50, the cohesion was 0.11 kg/cm², and the internal friction angle was 29.16°. These parameters were used as technical data in planning the external stability of the retaining wall so that the resulting design could be adapted to the on-site soil conditions. Additionally, field observations revealed that the soil layer at the base of the slope consists of rock, which can be assumed to provide excellent bearing capacity as the foundation for the retaining wall.

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