Slope Stability Analysis at Ban Mae Sa Mai, Pong Yang Subdistrict, Mae Rim District, Chaing Mai Province

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ABSTRACT

Landslides are natural hazards resulting from the downslope movement of soil and rock masses under the influence of gravity. Their occurrence is controlled by several factors, including soil properties, steep topography, climatic variability, and intense rainfall. Ban Mae Sa Mai, Pong Yang Subdistrict, Mae Rim District, Chiang Mai Province, has been identified as a landslide-prone area due to its steep mountainous terrain and there were reports of the past landslide events. In addition to geomorphological conditions, soil type and geological characteristics play significant roles in slope instability. This study aims to evaluate the engineering properties of the soil and assess slope stability within the study area. Field permeability testing was conducted, and soil samples were collected for laboratory analyses, including grain size distribution, Atterberg limits, natural moisture content, bulk unit weight, and shear strength determined by the direct shear test. The results indicate that the soil consists predominantly of sand (78.91–90.29%), with gravel (0.26–17.58%) and silt (3.51–23.44%). The average liquid limit, plastic limit, and plasticity index are 38.18%, 36.08%, and 4.66%, respectively. The average unit weight is 15.26 kN/m³, moisture content is 20.82%, internal friction angle is 32.80°, and cohesion is 0.42 t/m². Slope stability analysis using GEO5 indicates a factor of safety less than 1.50, suggesting low slope stability and a high potential for landslide occurrence.

INTRODUCTION

The study area at Mae Sa Mai, Pong Yaeng Subdistrict, Mae Rim District, Chiang Mai Province, is characterized by steep mountainous terrain and has experienced landslides in the past. Landslide susceptibility analysis using statistical models and historical landslide data (Department of Mineral Resources, 2021) indicates that approximately 0.32% of the total area of Chiang Mai Province is classified as high-risk landslide areas.

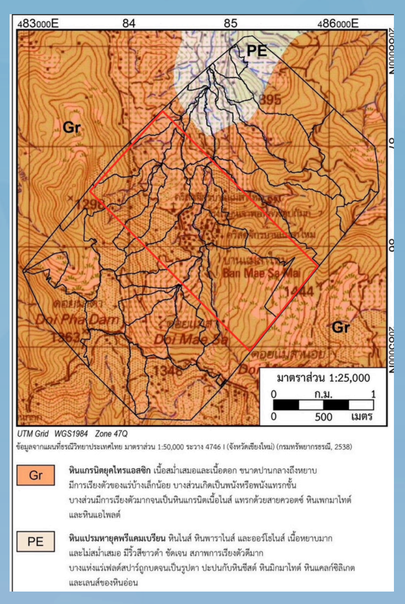


Fig.1 Geologic map of study area (modified from Department of Mineral Resources, 1995)

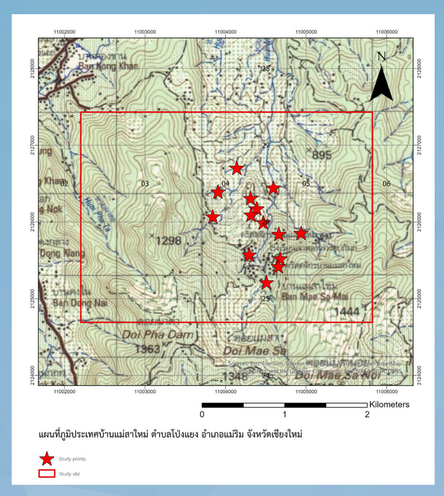


Fig.2 The map shows the sampling locations at Ban Mae Sa Mai, Pong Yang Subdistrict, Mae Rim District, Chaing Mai Province

METHODOLOGY

Soil Sampling

- Collected soil samples from 14 locations
- Focus on residual soil areas

Mechanical Testing

- Direct Shear Test
- Sieve Analysis
- Water Content

Laboratory Analysis

- Shear Strength
- Particle Size Distribution
- Atterberg's Limits

Slope Stability

- analysis using GEO5 – Slope Stability Program
- Soil Properties (γ, c, φ)
- Analysis Method and Calculation Factor of Safety (FS)

OBJECTIVE

1. To study the physical and geotechnical properties of soil.
2. To assess the landslide risk in the study area.
3. To analyze slope stability in the study area.

REFERENCE

Saenton, J. (2021). *Engineering Geology Course materials. Chiang Mai:* Department of Geology, Faculty of Science, Chiang Mai University.
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RESULTS

Fig.3 Atterberg's Limits

จุดศึกษาที่	หน่วยน้ำหนักดินเปียก (kN/m³)	ความหนาแน่นดินเปียก (kg/m³)	ปริมาณน้ำ (ร้อยละ)
MSM-1	15.15	1422.45	15.22
MSM-2	14.23	1543.98	18.02
MSM-3	15.90	1450.23	17.65
MSM-4	13.87	1620.37	22.43
MSM-5	14.19	1414.35	23.16
MSM-6	16.11	1446.76	21.59
MSM-7	15.87	1642.36	21.55
MSM-8	16.03	1634.26	15.15
MSM-9	16.80	1712.96	28.57
MSM-10	15.56	1585.65	23.13
MSM-11	13.65	1391.20	25.00
MSM-12	16.03	1634.26	20.00
MSM-13	16.78	1710.65	19.33
MSM-14	16.93	1782.41	20.70
เฉลี่ย	**15.62**	**1592.51**	**20.82**

Fig.4 Grain Size Analysis

จุดศึกษาที่	ผลการคัดขนาด (%)			Cu	Cc
	กรวด	ทราย	ทรายแป้งปนดินเหนียว		
MSM-1	6.49	87.73	5.79	9.96	2.10
MSM-2	15.64	79.18	5.17	15.14	6.60
MSM-3	13.80	81.69	4.51	12.39	6.52
MSM-4	17.58	78.91	3.51	9.22	9.89
MSM-5	3.41	90.29	6.30	7.96	0.69
MSM-6	12.97	80.22	6.81	16.33	3.63
MSM-7	0.26	82.54	17.20	10.21	0.26
MSM-8	0.34	88.78	10.88	16.81	2.23
MSM-9	0.26	76.30	23.44	11.30	0.14
MSM-10	4.44	90.0	5.56	8.82	1.38
MSM-11	7.83	84.65	7.53	10.56	1.44
MSM-12	7.51	84.64	7.85	14.90	3.19
MSM-13	6.43	87.26	6.31	9.91	1.83
MSM-14	7.14	87.04	5.82	10.76	3.06
เฉลี่ย				**9.96**	**3.29**

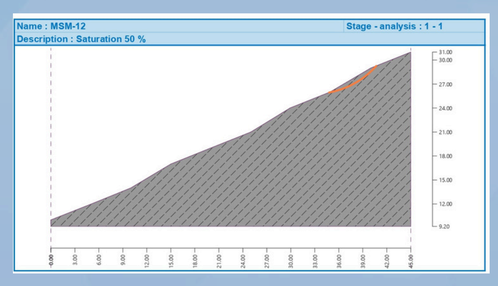
Fig.5 Direct Shear Test

จุดศึกษาที่	ครั้งที่	หน่วยแรงตั้งฉาก (t/m²)	หน่วยแรงเฉือนสูงสุด (t/m²)	มุมเสียดทานภายใน (องศา)	แรงยึดเหนี่ยวระหว่างเม็ดดิน (t/m²)
MSM-1	1	7.08	3.88	34.99	0.00
	2	12.64	7.28		
	3	18.19	11.66		
MSM-2	1	7.08	4.19	34.34	0.00
	2	12.64	6.79		
	3	18.19	11.79		
MSM-3	1	7.08	3.88	29.77	0.00
	2	12.64	6.79		
	3	18.19	10.25		
MSM-4	1	7.08	4.01	21.52	1.39
	2	12.64	6.73		
	3	18.19	8.40		
MSM-5	1	7.08	3.46	45.31	0.00
	2	12.64	8.21		
	3	18.19	14.69		
MSM-6	1	7.08	3.88	17.28	1.29
	2	12.64	4.44		
	3	18.19	7.35		
MSM-7	1	7.08	3.83	48.15	0.00
	2	12.64	7.84		
	3	18.19	16.23		
MSM-8	1	7.08	3.77	36.15	0.00
	2	12.64	7.84		
	3	18.19	11.88		
MSM-9	1	7.08	1.48	25.27	0.00
	2	12.64	3.33		
	3	18.19	6.73		
MSM-10	1	7.08	3.52	33.24	0.00
	2	12.64	6.60		
	3	18.19	10.80		
MSM-11	1	7.08	2.90	37.67	0.00
	2	12.64	5.80		
	3	18.19	11.48		
MSM-12	1	7.08	4.26	28.07	0.46
	2	12.64	7.16		
	3	18.19	10.19		
MSM-13	1	7.08	3.77	38.85	0.00
	2	12.64	7.78		
	3	18.19	12.72		
MSM-14	1	7.08	6.36	28.56	2.7
	2	12.64	10.00		
	3	18.19	12.40		
เฉลี่ย				**32.80**	**0.42**

Fig.6 Slope Stability Analysis

Sample	Degree of Saturation (%)	Factor of safety (minimum)	Factor of safety (maximum)
S-MSN-1	10	0.59	1.26
	30		
	50		
	70		
	90		
MSM-8	10	1.18	1.99
	30		
	50		
	70		
	90		
MSM-12	10	0.69	2.22
	30		
	50		
	70		
	90		

Fig.7 Slope Stability From Program



- **Atterberg's Limits**

The results indicate moderate density and high water content may reduce soil strength.

- **Grain Size Analysis**

Sand with fines may affect drainage and slope stability

- **Direct Shear Test**

The soil is mainly sand with low cohesion.

- **Slope Stability From Program**

Higher pore water pressure reduces the Factor of Safety (FS), causing slope failure.

CONCLUSION

The soil in the study area mainly consists of reddish-brown sand and silty sand with well-graded particles and low drainage capacity. The geotechnical properties indicate moderate shear strength. Slope stability analysis using GEO5 – Slope Stability shows that the Factor of Safety (F.S.) is lower than the standard value, indicating that the slope has low stability and a high potential for landslides.