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ANALYSIS OF SLOPE STABILITY FOR THE SLOPE CUTTING OF KENDRIYA VIDYALAYA PLAYGROUND, AIZAWL, MIZORAM

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ABSTRACT

Slope stability problem had never been solved completely and will never be because a slope has a natural tendency to fail. In most applications, the primary purpose of slope stability analysis is to contribute to the safe and economic design of excavation embankments, earth dams, landfills and spoil heaps. In this case, stability of soil on a hilly terrain is checked to know whether a level surface for playground can be made out or not. When dealing with slope in general and slope stability analysis in particular, geological and geotechnical experience in an area is valuable. In this study the properties of the soil by various types of soil test has been determined using specific gravity, liquid limit, plastic limit, moisture content, dry density, permeability and parameters such as cohesion (C) and angle of internal friction (i). By knowing the parameters of the soil, slope/w analysis were performed using Morgenstern Price Method and factor of safety was determined for different height and with different inclined angle. It has been found that the hill side slope cutting has a factor of safety at the height of upto 14 m, with slope angle of 32.47^{0}.

KEYWORDS: Slope stability, Limit equilibrium method, Landslide.

1. INTRODUCTION

Landslide is a major natural geologic hazards causing loss of lives, damage to houses, roads and other infrastructures [1-4]. Rapid increase of man- made stuctures, fast expansion of road networks and growth of population lead to high vulnerability of human lives and properties. Landslide therefore, becomes a disaster when it occurs in such human habitations [5]. Geologically, Mizoram comprises N-S trending ridges with steep slopes, narrow intervening synclinal valleys, dissected ridges with deep gorges, and faulting in many areas has produced steep fault scarps [6]. Therefore, settlement areas along with roads in Mizoram are highly vulnerable to landslide disaster.

Slope instability is a result of stress exceeding the shear strength of the slope material. The excess stress could be added with increasing pore water, excessive overburden pressure due to external load, etc. Moreover, poor soil condition, weathering, slope geometry, soil stratification, discontinuities in the rock body, etc. are some other common factors to decrease soil strength for slope instability [7]. Slope height and steepness is also pivotal with increasing slope height, surface runoff and water transport energy also increase by the action of higher gravity, and at the same time steep slopes tend be eroded more quickly; both leads to instable slopes[8].
Factor of safety (FS) is a very popular term that civil engineers use ubiquitously for risk free infrastructure development, and as a classical approach to project the possible relationship between soil strength and expected stress. Among various geohazard, landslide is a potential one that is reported to cause serious damage to life and properties. That is why engineering structures in landslide prone areas are needed to be given proper design and strength considering the appropriate FS value along with proper site selection. In this research, FS values were determined following the conventional limit equilibrium method for slope stability analysis. [9-10]
The limit equilibrium method is a common and widely used procedure for slope stability analysis. Simplicity and requirement of less parameter compared to other methods have hold popularity of this method up even though the method has disadvantages like constant FS along the slope plain, and negligence of ground response [11-15]. Slope stability analyses with inhomogeneous dip and/or soils are now done by software. But, slopes

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with homogeneous inclinations and isotropic soils are conventionally studied, for slope safety, by charts as a quick tool [16-19].

2. METHODOLOGY

The following tests are done to determine the properties of the soil by taking the soil from nearby Kendriya Vidyalaya(KV) playground inside Mizoram University. The following laboratory test has been conducted:

1. Specific Gravity Test
2. Liquid Limit Test
3. Plastic Limit Test
4. Standard Proctor Test
5. Coefficient of Permeability Test
6. Water Content Test
7. Direct Shear Test

The study of slope stability was done using the computer based geotechnical software code slope/w (Geoslope 2019). The factor of safety (FOS) has been determined using limit equilibrium (LEM) within the Morgenstern – Price method along with Mohr-coulomb expression. Laboratory test had been conducted on soil to get the shear strength parameters of soil (Cohesion and Phi value) and unit weight, permeability, specific gravity, water content, liquid limit and plastic limit.

3. EXPERIMENTAL STUDY

The soil sample taken from the site is tested in the laboratory as per IS codes. The different experiment test has been carried out to know the soil properties as shown in table 1.

Table1. Experimental values of Soil Properties

Sl No	Name of the experiment	Result
1	Specific Gravity	2.5
2	Liquid Limit (%)	44.14
3	Plastic Limit (%)	29.82
4	Plasticity Index (%)	11.13
5	Dry Density (g/cc)	1.87
6	Optimum Moisture Content (%)	12
7	Co-efficient of Permeability (cm/sec)	8.72×10^{-4}
8	Angle of Internal Friction (°)	20
9	Shear Strength Value (N/mm2)	6.127×10^{-3}
10	Cohesion Value (kPa)	4.5

Plastic Limit and Liquid limit value which are 29.82 %, 44.14% from the test results have indicated that the soil is alluvial clay soil. Plasticity value 11.13% has further indicated that the alluvial clay soil is silty clay soil which is having medium plastic and cohesive. It has been found out that the degree of permeability is low based on permeability test result as the soil is clayey soil. The direct shear test has indicated that the soil is soft silty clay with average shear strength value. It can be summarised that the soil which is silty clay, plastic, cohesive with low degree of permeability.

Slope Analysis

Slope/w is one of the software products for computing the factor of safety of Earth and rock slope. With slope/w, simple and complex problems can be analyzed for a variety of slip surface shape, pore water pressure

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condition, soil properties, analysing method and loading condition. Using limit equilibrium, slope/w can model heterogeneous soil type, complex stratigraphic and slip surface geometry and variable pore water pressure condition using a large selection of soil model.

Table 2 Factor of Safety with respect to different height of cutting

Parameter	H = 14m	H = 20m	H = 25m	H = 30m
Cohesion (C)	4.5kPa	4.5kPa	4.5kPa	4.5kPa
Unit weight of soil	18.48kN/m^3	18.48kN/m^3	18.48kN/m^3	18.48kN/m^3
Angle of internal friction(ϕ)	20 º	20 º	20 º	20 º
FOS (i = 32.47 º)	1.23	1.19	1.04	1.05
FOS (i = 41.99 º)	1.04	0.87	0.93	0.81
FOS (i = 50.19 º)	0.83	0.75	0.67	0.64
FOS (i = 60.95 º)	0.59	0.79	0.66	0.47

4. CONCLUSIONS

- The properties of the soil using the laboratory test and plasticity chart is found out that the soil is inorganic silty alluvial clay with medium plasticity having unit weight 18.48 kN/m^3 **,** cohesion = 4.5 kPa and angle of internal friction **(ϕ) =** 20 º.
- The factor of safety of the slope stability decreases with an increase in height of slope and increase in inclined angle of slope.
- For height upto 14 m, the structure is considered safe when slope angle is less than or equal to 41.99 º. Increase in height decreases factor of safety.
- Slope angle of 32.47º is considered safe with different height ranging from 14m to 30m.

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