033 Mechanism and Stability of the Shallow Landslide in Mt. Aso Region

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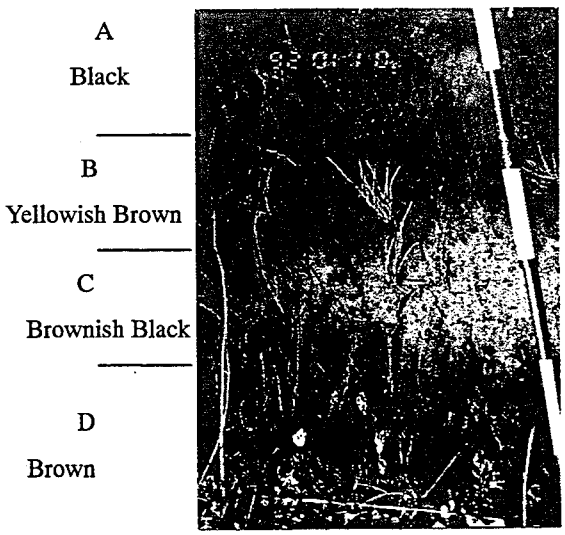
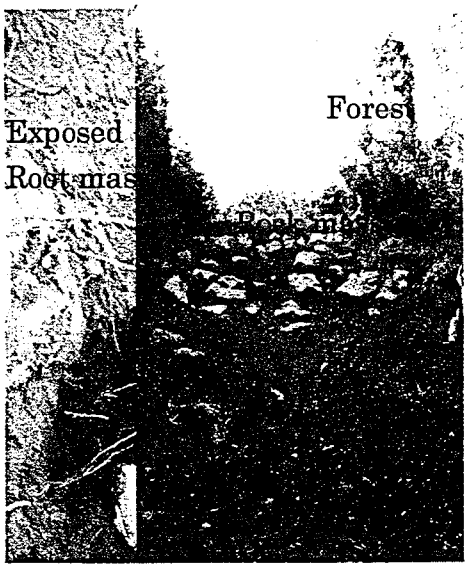
1. Introduction

The flank of Mt. Neko dake, the part of Mt. Aso region is dissected by a number of shallow landslides. The land use of the study area is differentiated into forest and pasture areas. The total study area comprises about 5.5 km^2. The relief of the study area is 300 m and receives annual rainfall much more than 3000 mm. The maximum slope angle is up to 63°. The muddy slipped material was flowed down along the stream. The flowed mass was also trapped to the twigs of the *Hinoki* trees lying along the stream bank during the course of flow. Some of the trees along the bank were uprooted and some were leaned by the impact of mudflow. Along the bed of stream there is a sediment deposition too. Majority of the shallow landslides were found to occur between 30°- 40° slope angles. Nearly 90% of the shallow landslides have surface area less than 1000 m^2. Basically the soil horizons are differentiated into 4 layers named as A, B, C and D horizons. The specific gravity, hardness, moisture content, porosity, cohesion and internal friction angle were identified for each soil horizon. The major species in forest area is *Cryptomeria japonica* mixed with *Chamaecyparis obtusa.* In pasture area the grass species *Miscanthus sinensis* and *Zoysia japonica* are common. The grass's roots in pasture did not penetrated below the sliding plane, while in forest roots were seen penetrating below the sliding plane of shallow landslides. The landslide distribution numbers are higher in pasture than in forest. The majority of the forest area comprises matured tree species mixed with rock masses. The aim of this study is to present case study about the relative slope stability and mechanism of shallow landslides in forest and pasture surfaces.



View of soil horizon differentiation



View of a shallow landslide in forested slope

2. Methodology

The undisturbed soil samples taken from the immediate site of the shallow landslide were tested in the laboratory by the direct shear box in four different vertical stresses of 0.25 kgf/cm^2, 0.5 kgf/cm^2, 0.75 kgf/cm^2, and 1.0 kgf/cm^2 to find out the cohesion and internal friction angle of soil. The other geo-technical properties of each soil horizon like moisture content, density, permeability, porosity and hardness were also tested. The hydrometer test was carried out for soil held on to the branches of trees to determine the grain size distribution. The slope stability has been analyzed based on the soil strength parameters taken from two different sites of forest and pasture slopes and with topographic parameters. The height of water table was assumed at half of height of depth of failure surface.

The following infinite slope stability equation has been used to calculate the slope stability.

$$F_s = \frac{\frac{c'}{\gamma.Z} + (\cos^2\beta - \frac{\gamma_w.h}{\gamma.Z})\tan\varphi'}{\sin\beta.\cos\beta}$$ where,

F_s = safety factor, γ = unit weight of soil (kN/m^3), γ_w = unit weight of water (kN/m^3), Z = depth to the failure plane (m), β = slope angle (degree), φ' = internal friction angle with respect to effective stress (degree), c' = cohesion with respect to effective stress (kN/m^2), and h = water table height (m).

3. Result and Discussion:

The following results were obtained from the laboratory test carried out for forest soil and pasture soil.

The height of water table, h has been assumed as $h = Z/2$.

Forested slope: $C' = 8.54$kN/m^2, $\varphi' = 23^0$, $F_s = 1.3$.

Pasture slope: $C' = 6.70$ kN/m^2, $\varphi' = 21.22^0$, $F_s = 0.9$

So as to understand the relative slope stability in forest and pasture under similar assumed ground water condition the safety factor has been calculated. Although the height of water table was assumed in between of the depth of slip surface and ground surface yet the relative stability index was different for forest and pasture slope. In forested slope the safety factor became slightly higher than 1.0. It might be due to fact that the strength properties of the soil sample taken from the landslide site might have greater strength than that of the slipped soil mass. The hardness of soil layers, measured by Yamanaka System Hardness Tester, is 9.6, 8.25, 10.2 and 15.6 mm for A, B, C and D horizons respectively. The hydrometer tests show that the soil held on to the twig surface was composed up of 64% silt, 28% sand and 8% clay particles. The permeability of B horizon is lowest as compare to C and D horizons. Where lower horizons are more permeable than surface horizons an upward pore water pressure may develop and promote shallow landslide. During heavy rainfall the soil loss the shearing strength and influence of upward pressure might have cause the slope failure. In pasture the influence of localized pore water pressure is seems to be higher as compare to forest. In forest area the roots of the trees and the rock masses present on the ground surface might have played role for its greater slope stability. These differences of site factors in pasture and forest might have lead to variation for shallow landslide occurrence. This is a case study and for complete study other parameters like geology and volcanic effect is also needed to incorporate.