Investigation on disaster scale and mechanism of a deep-seated landslide – Mei-Hua area in Taiwan as an example

Sheng-Chuan Chen, PhD[1]; I-Feng Chiu, M.S.[1]; Chao-Wei Chen, M.S.[2]; Chao-Chin Pai, M.S.[2]; **Kai-Chun Yang, PhD**[1]

INTRODUCTION

Taiwan island is located at the boundary between the Philippine Sea plate and the Eurasian plate. Owing to the orogenic influence, Taiwan island has a steep topography and fractured geologic structure. Moreover, abundant rainfall and earthquakes occurred frequently that is adverse to slope stability. As a result, landslide or debris flow can be easily triggered under such conditions. According to past experiences with cases, the interface between soil and rock layers or between sandstone and shale is usually prone to be the sliding surface. However, if the stratum structure is fractured or interface between rock strata is invisible, it will be not easy to determine the sliding surface. This study focused on a deep-seated landslide named Mei-Hua landslide area with colluvium thickness of 50m, which is located Hsinchu county, Taiwan. This area include a community with a population of about 400 and the Mei-Hua elementary school. During the Typhoon Haitang in 2005(accumulated rainfall up to 600mm in 3 days), lots landslide disasters include cracks of buildings, retaining walls and roads have been occurred, and part of this area recently still shows unstable phenomenon.

METHODS

In order to determine the range of landslide and find out the topography features of landslide, the digital topographic map of LIDAR is making use in this research, which will be compared with the surface geological investigation results to verify the interpretation result of LIDAR. Moreover, geology drillings are performed to study the geologic structure, the configuration of borehole, inclinometer and water observation well is shown as Fig. 1. According to the investigation results, Mei-Hua landslide area is found that is located on a main stratum of colluvium about 50m depths. And the colluvium layer can be subdivided into upper and lower layers produced from different time periods of landslide events according to its particle sizes and the degree of tightness between rock and soil. The composition of colluvium layer is complex in this research area, and it is not easy to determine the location of sliding surface. Therefore, in order to assess the sliding depth, inclinometers had been used to measure the displacement since 2012. Rainfall and groundwater table are also observed to study the relationship between rainfall and rising of groundwater table. In order to determine the possible location of water bearing layer and groundwater flow direction, too.

RESULTS

Investigations results indicate the research area can be divided into S1~S4 sliding masses. S2 is the main sliding mass with area 9ha and the sliding depths are about 60m~70m. The range of influence of S2 is from Mei-Hua elementary school to Jinping river (Fig. 1). Based on interpretation result of LIDAR and in-site investigation, there is a cliff collapse with 40~50m long and 3~5m height above S2, and this would be the cause to form S3. According to current observation result, S3 doesn't show visible sliding condition. S1 is located at the toe of S2 with area 6.5ha and sliding depths from 25~35m composed of many isolated masses. S4 was determined by LIDAR for its topography features of landslide area, but the slope sliding warnings such as surface cracks or structure fractures are not clear, the activity of S4 is still required to trace and ensure by long-term observation works.

Base on the rainfall and groundwater table observation results, Mei-Hua landslide area is relatively stable with less rainfall, however, after special event such as typhoon or heavy rain, the slope began to have signs of movement. Thus, the slope stability of this area is closely related to groundwater level. To find the possible distribution and flow path of

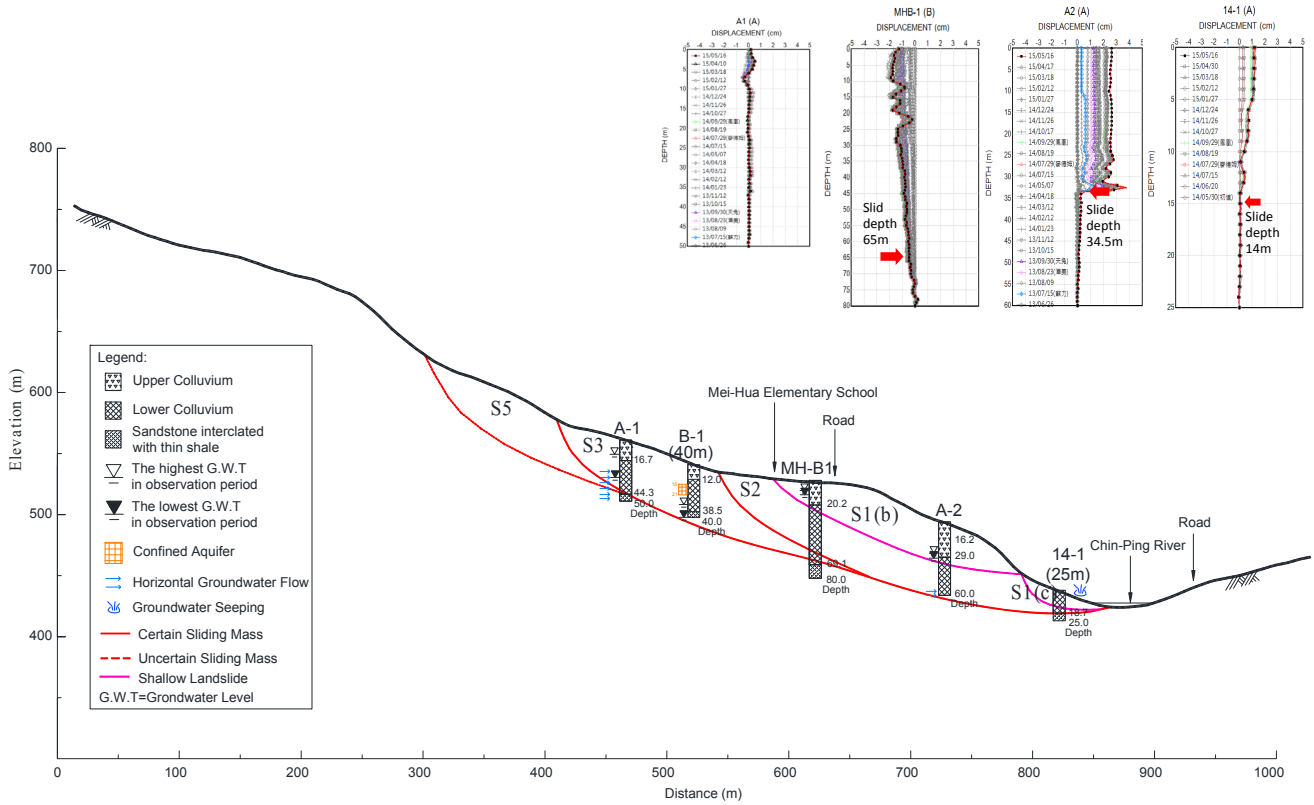

Figure 1. Cross section of sliding masses

groundwater as a reference for subsequent overall improved planning, a comprehensive site survey, measuring of groundwater table, ground resistance test and groundwater logging test are performed and summarized. According to these investigation results, the groundwater flow path in Mei-Hua area could be divided into A and B flow paths.Partial surface drainage systems and middle depth of groundwater discharge (slope drains) had been finished in 2014, both were accomplished with good effectiveness. This also indicates the content of groundwater in Mei-Hua landslide area is abundant and the evaluation of groundwater flow paths in this research is correct.

DISCUSSION

As aforementioned observation, the groundwater would be the main cause of disaster on the slope. It is possible to happen slope failure if groundwater cannot be discharge out during the period of typhoon. Base on the experience of disaster since 2005, slope creep potential will happen when daily rainfall obtains 250mm, and if daily rainfall keeps enhance to 600mm or even more than 1000m, the possibility of rapid and large-scale slope movement is required further study. According to the observation results, the raise margin of groundwater and quantities of slope displacement is less at the similar rainfall condition after surface drainage systems and middle depth of groundwater discharge finished in 2014. To reduce the risk of slope disaster for residents live in Mei-Hua area, the overall improved engineer to control groundwater table below the sliding plane is still necessary.

KEYWORDS

Deep-Seated landslide; Observation; Sliding Depth; Geologic Investigation; groundwater

1 Taipei Branch, Soil and Water Conservation Bureau, Council of Agriculture, Executive Yuan., New Taipei City, TAIWAN, narc0816@gmail.com
2 Land Engineering Consultants, CO., LTD, TAIWAN