CHAPTER 1

INTRODUCTION

1.1 Background

Deformation refers to the changes in shapes, dimension and position (horizontal and/or vertical components) of a deformable body (natural or man-made objects). Large engineering structures are subject to deformation due to factors such as changes of ground water level, tidal phenomena, tectonic phenomena, land movements, or any other natural disasters [1].

Nowadays, the monitoring of construction objects and dangerous areas are becoming more and more important due to structure failures, environmental factor and their potential hazard. Road is the main type of transportation system in Malaysia. About 30% of these roads traverse through or located in hilly and mountainous areas. These mountainous roads experience numerous landslides, which cause disruption, injuries and losses to life and economy.

Preventing large, natural landslides is difficult, but common sense and good engineering practice can help to minimize the hazard. Common engineering techniques for landslide prevention include:

i. Monitoring various surface and subsurface engineering methods
ii. Provisions for surface and subsurface drainage.
iii. Removal of unstable slope material.
iv. Construction of retaining walls or other supporting structures, or combination of these.

On this fact, a research effort must be taken seriously to reduce the likelihood of catastrophic collapse of the active landslides. Therefore, the need for monitoring and maintenance is seemingly very important, so that if any significant deformation is detected, early mitigation measure can be taken.

When carrying out surveys in these dangerous areas, staff safety is the primary concern. It involves periodic and automatic measuring of reference points in or around the active area to determine the deformation. When movement tolerances are exceeded, it is often necessary to immediately analyze the measured data to activate response events [2]. Monitoring tasks and deformation analysis present some of the most sophisticated challenges in the surveying profession today because they require the highest accuracy.

There are many different types of sensors used for deformation measurement. Generally, they can be grouped into two methods: geodetic methods and non-geodetic methods (or also known as geotechnical or structural methods). Geotechnical and structural methods are usually adopted by civil engineers who use special equipments to measure changes in length (extensometer), height (settlement gauge), strain (strain meter), inclination (inclinometer) and water pressure (pyrometer) [3]. On the other hand, geodetic method is highly used and understood by surveyors. Special measuring techniques that could be applied for this technique are Global Positioning System(GPS), close range photogrammetry, precise leveling, Total Station, laser scanning (terrestrial survey), Very Long Baseline Interferometic(VLBI), Image by Interferometic Survey(IBIS) and Satellite Laser Ranging (SLR)[3].

The monitoring of slope deformation can be made by using technology like reflector-less Total Station. This is because the reflector-less Total Station distance measurement technology works well and is accurate enough in most application. Reflector-less Total Station is not only accurate but also reduces the number of mans power as it does not need a man hold or handle the prism pole. Measuring and monitoring by this technique can be performed at inaccessible location like high rise buildings, hill side dangerous slope, tunnel, open pit mining area etc.

Each of the instruments and measurements technique has its own advantages and disadvantages. The selection of most appropriate technique or combination of techniques for any particular application will depend on instrument technology, technical support or experts, survey specification or procedures, the accuracies required, and the scale of the survey involved.

1.2 Problem Statement

In the past few decades many applications have been introduced and successfully applied in geodetic monitoring. Some of the popular methods are Global Position System (GPS), close range photogrammetry, terrestrial survey, laser scanning, very long baseline interferometry and satellite laser ranging. Most of the methods have different approaches and accuracy levels and they depend on the size of potential hazards and type of instruments used.

The methods mentioned above involve substantial use of man powers because they need a co-operative device to be placed at the target; in tachometry a prism, in Global Positioning System (GPS) a rover receiver – which means that someone has to set up the device there, and in satellite laser ranging there is difficulty in accessing the satellite image from authorized organization. Latest technology such as laser scanning has high resolution but is still relatively expensive.

To overcome problems mentioned in the above methods, reflector-less Total Station method is introduced. In terms of economic advantage, reflector-less will increase the number of surveyed points, as prisms are no longer need to be fitted. Not only the costs for the prisms are saved, but also high installation expenses can be reduced.

1.3 Research Objectives

The main purpose of this research is to study the application of a reflector-less Total Station as a data acquisition tool in slope deformation monitoring. The study has been carried out to meet the following specific objectives:

i. To determine the zero and scaling factor of targets made from various materials based on colour and texture.
ii. To employ the reflector-less Total Station method in landslide deformation monitoring.
iii. To analyze and determine the magnitude of mass movement in landslide.

1.4 Scope of the Research

The scope of this work is to study the application of a reflector-less Total Station in slope deformation monitoring. The study is divided into two parts namely equipment calibration and field measurement. The calibration was conducted at Electronic Distance Measurement, Survey and Mapping Department Malaysia, (JUPEM EDM) baseline at Kinta Golf Club, Batu Gajah, Perak. The equipment was calibrated using different materials to obtain the value of zero error from the material of various surfaces. The accuracy of the TS is then compared to the standard specification of the instrument. The calculations used in this research (to determine zero error and Total Station calibration) were parametric least-square adjustment. Once the instrument is confirmed to be in good condition, field investigations were carried out by observing three (3) epochs within a six month gap of each other. The investigations were carried out independently using the reflector-less Total Station to monitor slope deformation at selected areas. The data acquired from the 3 epochs were processed, validated, adjusted and analyzed to obtain the actual result, and to verify the quality of the reflector-less Total Station in slope deformation monitoring, this result were be compared with the data measured using standard prism Total Station.

1.5 Outline of Thesis

An overview of deformation monitoring using reflector-less Total Station is given in the background section of this chapter, followed by problem statement, objectives, scope of study and outline of the thesis.

Chapter 2 outlines the literature review on deformation concepts and theories, previous investigations on instrumentation as well as best practices and guidelines.

Chapter 3 describes the experiment procedures and processes involved in the research. Essential fundamental concepts and theories pertaining to the research methodology are also highlighted.

Chapter 4 focuses on the results and discussions of the work done.

Chapter 5 gives an overall summary of the research, followed by the conclusion of this work and recommendations for future work.