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Evaluation of Limit Equilibrium and Finite Element Methods in Slope Stability Analysis - Case Study of Zaremrood Landslide

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ABSTRACT

In general, landslides are events that occur, due to instability in the slope, causing the movement and displacement of an earth mass constituents from a slope to downward. Earth drift may occur due to underground activities or slope changes. One of the factors of the instability of the slopes is gravity, and therefore the main method of their stabilization is to reduce destructive force and increase the resistance force. Water is another cause of earth instability, which leads to degradation and erosion at the surface, and in deeper sections, in addition to erosion, it also causes pore water pressure and decreases soil resistance. Iran, with its mainly mountainous topography, tectonic activity and high seismicity, diverse geological and climatic conditions, has major natural conditions for creating a wide range of landslides. The resistance of earth surface against sliding is called slope stability. Slope stability analysis includes methods used to evaluate the equilibrium and safety conditions of natural and man-made slopes (embankments, open pit mines, excavations, etc.). The main purpose of these analyzes is to find critical areas with the potential of falling, investigate the possible failure mechanism, determine the slope sensitivity to various mechanisms, optimal slope design with respect to safety, achieving high reliability, observing economic aspects and designing possible options for slope retention. The choice of the correct method for analyzing slope stability depends on the location of the project and the probable failure mode. For having a right choice, it must be considered the strengths, weaknesses, and limitations inherent in each method. Before the advancement of the computer softwares, slope stability analyses were performed graphically or by manually calculating. Today, there are many software options available for engineers, such as limit equilibrium methods and numerical solutions. One of the most important challenges for users of these softwares is the difference between their results, in the estimation of the stability of a slope and the assessment of the factor of safety. This paper presents a case study of the contingency of landslide in an earth slope in the Zaremrood, Mazandaran, Iran. In this study, the results of the investigation of the limit equilibrium method used in Geostudio-SLOPE/W software have been compared with PLAXIS software which exploits finite element modeling method.

Keywords: landslide, slope stability, limit equilibrium, finite element, numerical method

1. INTRODUCTION

Landslide is the movement of rock, soil or collapse on a slope[1], which are unstable for various reasons such *as* earthquakes, road construction or etc. Landslide is one of the main land-formation processes that has influenced the evolution of the landscape of mountainous regions[2]. Landslides are affected by many destructive factors such as earthquakes, rainfall, and quickly melting of snow, as well as factors such as topography, rock and soil type, fractures, bed surfaces, and moisture content[3, 4]. The main factors of the rock and soil mass motion are gravity, earthquake, road construction, increasing the water pore pressure due to the rain, removal of earth from the downstream of the slope and many other factors. The downward movement in the landslide may occur very slowly (only a few millimeters a year) or at a very rapid rate and will have disastrous effects. In each assessment, information on landslide extension must be unified, as serious damage occurs in the early stages of the landslide. For instance, the propagation of the tension cracks and formation of head scarp structures can seriously damage roads or buildings, etc. in the affected