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The Association of Constructing Forest Roads and Earth Mass Wasting

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Abstract: *Mass wasting (slope movement) is a natural phenomenon which causes extensive damages and losses to different parts of Iran every year. Vegetation (forests) plays an important role in the stability of hillsides and forest roads. Forests have been considered as significant and effective factors which prevent mass wasting in mountainous areas. Therefore, it is very important to investigate the relationship between the road construction in the forest areas and mass wasting to provide useful solutions for this problem.*

Keywords: *Mass Wasting, Road Construction, Forests.*

INTRODUCTION

The most important natural disasters which threaten the mountainous and forest roads are slop-slip and landslide (Orimoogunje, 2014). These phenomena are more frequent during the road construction as it may disturb slop balance. Roads have been regarded as significant elements of modern civilization and they can make economic and social development in the areas (Guo et al., 2015). The capital which is used to establish the road network in various geographic areas and to maintain and make the roads safe is regarded as national capital (Mendes & Filho, 2015). It is essential to protect the national capital to make a long-term utilization of the road network (Mendes & Filho, 2015). Having safe and secure road is regarded as a development criterion. Basically, the development of the communications and roads is very important in making sustainable development. In order to facilitate the sustainable development, it is significant to make desirable and sustainable roads (L'opez-Vicente et al., 2013). Mass wasting is an important geo-ecosystem process in the nature ranging from mild hills to steep mountains (Gruber et al., 2009). Every year, mass wasting causes both losses of life and property in several areas. Although extensive studies have been carried out all around the world to investigate causes, mechanism, risk, zoning and prevention and control of mass wasting, unfortunately, they have not been adequately taken into account in Iran and have been implemented in a sporadic manner and according to the tasks of the organizations (Yamani et al., 2011).

The mass wasting classification

Mass wasting which are called slope and mass movements as well, are geomorphic processes in which soil, sand, stone and mass rock move down the slope mainly due to gravity force and also underground water and mud flows (Naghdi et al., 2013). Types of slip wasting include moss, slipping, range from a few seconds to several years (Guerra et al., 2017). Typically, the classification of landslides and the mass wasting phenomenon is done according to their type of wasting (slipping, flowing and having heavy material), or based on the speed of wasting and the amount of water (dry rock materials or land materials with varying proportions of water and ice). However, gravity is the main factor in the movements (Nacinovic et al., 2014). A. Vertical movement: Two types of movements can be identified as vertical displacement. One is the fall of soil from the surface of the rock, and the other is subsidence due to the movement of the submerged material. The fall of the ground, for example the caves roofs falls lead to the formation of ups and downs called karsts. Another condition of subsidence can be the result of the fluid loss in the permeable material. B) Lateral movement: Lateral movement of the materials are referred to as two types of wasting, i.e. slip and dispersion of materials. Slip is a transferring movement that usually occurs along a horizontal surface or a mild slope. Also, the material dispersion is the lateral movement of a series of boulders in a way that they get away from a center. In this category, there are a variety of bending properties. In this phenomenon, sedimentary rocks move on the slopes of the hills. Meanwhile, the bottom sediments of this cover also move toward the valley. C) Diagonal movement: In this movement, the materials move down the slope and get away from the initial point, and when it is compared with the lateral movement, it is found that there is more gravity involved in it. This classification offers three types of movement including creeping, slipping, and flowing (Tang et al., 2018).

Factors affecting mass wasting of materials on forest roads

Mass wasting of material is the disposition of weathered materials and the rocks on the slopes due to the gravity force. Forest areas are completely susceptible environments for landslide and mass wasting of the soil, so that inappropriate design of forest roads in these areas can exacerbate this phenomenon (Majnounian et al., 2010). Therefore, identification and classification are the most important factors in mass wasting occurrence in order to find appropriate management strategies to prevent and predict its occurrence in sensitive areas. In general, some factors cause instability of the slope including effective factors in increasing shear stress and effective factors in decreasing shear strength. There are different factors effecting the mass wasting occurrence such as ground factors, topography, climate, vegetation cover and human (Sadeghi and Attard, 2014). Thus, the main factors affecting the slipping slope are soil texture instability, humidity, substrate type, slope and humidity. Therefore, clay, along with other conditions such as humidity and topography, and stimuli resulting from artificial manipulation, activate the slip. It can be said that mass wasting is very complicated and its creation factors are not constant, and in each region, certain factors cause mass wasting. In natural resources management, optimal and sustainable exploitation of natural and artificial forest products is possible regarding the construction of the forest roads. One of the important issues in creating such roads in mountainous regions is the occurrence of the mass wasting that disturbs the ecological balance and has changed ecosystems of the region (Abedi et al., 2010). The previous studies have shown that the massive mass wasting occurs in the forest roads since the frequency of slipping and falling raises. Besides, regarding the geographical factor of the slope, it has been improved that mass wasting intensifies in the high slope while the percentage of vegetation cover is inversely associated with the mass wasting. Therefore, the less vegetation cover, the more mass wasting occurs (Mohammadi Savadkoohy & Hosseini, 2012).

Figure 1. An example of erosion of mass wasting in the real world

The Importance of Cut-slope stability on Forest Roads

The instability of the slopes and the mass wasting of the soil have always been one of the concerns of the experts and construction engineers as well as the environment experts (Felegari et al., 2013). Soils are the main building materials of forest roads and they form its bed simultaneously. Cut-slopes are terrain hills located on the side of the road that can be natural or artificial made during the road construction. Road construction is one of the factors behind the creation of the cut slope (Shanmugam & Wang, 2015). If road construction is carried out without being aware of the soil characteristics where the road is supposed to be constructed, it will have dangerous consequences, such as the high cost of the road construction, maintaining and rebuilding roads in the soils sensitive to the mass wasting and the construction of retaining walls for the stabilization of surface soils and cut slopes (Sepúlveda et al., 2016). The cut slope stability is generally a relative issue; in other words, a slope is not permanently stable. In engineering views, examining the cutaways and natural cut slopes in the area is a valuable guide to design the slope (Azzam, 2014). Slop stability analysis is essential for all cuts that are more than 6 meters high and also have loose, soft, cracked or water-soaked soils. Therefore, the stability of the natural or artificial cut slopes that may have been caused by digging or grinding, must be controlled by the designing engineer in many situations (Taherkhani & Javanmard, 2015). In this kind of control, the shear stresses created along the slip surface, should be calculated and compared with the shear strength of the soil. Such a process refers to the stability analysis of the slope. It should be noted that due to the large size of the area and high number of the samples, it is usually expensive and time-consuming which reveals the need to find a way to optimize the samples (Hosseini et al., 2018).

Conclusion

Forest roads are considered as one of the most important infrastructures to manage the forestry projects. The main problems which may occur in the mountainous forest roads are landslides, drifts and mass wasting. However, regarding the nature and diversity of the mass wasting, they are considered as dangers for human life and property and they have been investigated by scientists from various fields of study such as geology engineering, geomorphology, watershed management, and so on. Since it is a complicated phenomenon, a complex mechanism and complex factors can be effective in creating it. Extensive studies have been done in identifying the effective factors, categorizing, zoning and modeling this process. Mass wasting , like other natural phenomena such as earthquakes, volcanoes, and so forth., have attracted human attention since mass wasting threatens the lives and property of human, and also, it affects agricultural lands, forests, transmission lines and gas, mines, engineering structures and buildings which economically cause many problems. Being aware of the characteristics and factors affecting the creation and expansion of mass wasting, it is possible to find some methods to predict the hazards and to prevent the damages and losses caused by their expansion. In addition, the rapid growth of population in recent decades, the expansion of cities to mountainous and high areas, and the need to construct mountainous and forest roads, and the greater involvement of human beings in nature have caused an increasing number of mass wasting occurrences and an increase in the number of casualties in recent years. Despite the increase in human knowledge about the mechanism of the occurrence of landslides and their controlling factors due to the efforts of many researchers and enthusiasts in different countries, it is predicted that they are going to become more dangerous in the future due to the ever-increasing human changes in nature and the use of mountainous areas susceptible to landslides, and damages caused by them. In Iran, regarding the extreme irregularity of mountainous areas, high seismic activity, various geological and climatic conditions, and natural conditions for a wide range of mass wasting is appropriate. Every year a large group of people suffer from a lot of life and property losses in Iran. Therefore, determining and investigating the susceptible areas and mapping of hazardous mass wasting risk can provide a valuable contribution to planning and construction development experts.

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