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Review Article

Soil Parameters of Creep Movement Şirinköy-Denizli Example

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Seismic Multi-Channel Surface Broadcast (MASW),
Creep,
Ground Conditions,
Geophysics.

Abstract

This study, it is aimed to determine how soil parameters affect mass movement. The study area was carried out in the Şirinköy District of Merkezefendi District of Denizli. As a basis for the prevention of mass movements; Geophysical methods are of great importance in terms of determining and monitoring the properties of the sliding forces by determining the ground conditions in the region. For this reason, in this study, the characteristics of the mass movement were determined by determining the soil properties of the study area by using the seismic multi-channel surface wave (MASW) method, which is one of the geophysical methods. With the MASW method, it was determined that the seismic velocities of the area were lower than 910 m/s. The boundaries and units of the geological formations of the ground in the region have been determined. Limestone and fill surface slip surfaces in the area were observed in MASW sections. By evaluating all these studies together, the mass movement in the region was determined as slow flow (creep). Blocky limestone detected in the study area (it is the unit that relatively forms the slip surface. For this reason, developments such as groundwater, growth of roots of plants and trees, wetting, drying and freezing of the ground with the effect of precipitation may cause an acceleration of the movement speed should be followed.

1. Introduction

Disaster, which is one of the most important situations in the world, is a situation that cannot be predicted in terms of time, duration and severity by using the possibilities of technology in general. Depending on the conditions of occurrence, natural disasters can trigger each other. For this reason, before the urban settlement and construction decisions are taken, decisions should be made such that the region should be sensitive to disasters or if non-sensitive areas can be made sensitive, they should be made or completely removed. Therefore, the concepts of urbanization and disaster are intertwined with each other and are too important to be considered separately. For urban settlement and construction to be sensitive to disasters, site selection, housing conditions and the effects of housing should be examined and planned one by one. By making these plans, disaster damages and environmental disasters can be minimized [1].

In the study of Dağ and Bulut (2012) [2], earthquakes and landslides are seen the most in Turkey. Most of the landslides are seen in the Black Sea region, especially after precipitation. In the Black Sea region, landslides are more important than earthquakes.

Öztürk (2002) [3], in his study, a landslide is the shape and displacement of the non-stationary parts of the mass along the slope due to the effect of gravity as a result of the slope being higher than it should be.

Önay (1946) [4] investigated the geology, mass movements and causes of the Babadağ district.

In the study of the General Directorate of Highways (2015) [5], if the geological formation is a rock, the structural features of this unit (crack, layer and schistosity) are the slip shape defined kinematically according to its location and the sloping plane and the geometric position it gives. Depending on these structural features, a failure occurs in the form of turning or overturning from the axis of the structural feature. Debris and soil overturning are rather the cohesion of the unit and slope are the more effective parameters, and effects such as groundwater, precipitation rate, geometry, and freeze-thaw are also important factors in the realization of the movement. Jongmans and Garambois (2007) [6], the use of geophysical methods to study the extent of mass motions is increasing thanks to advances in ground imaging techniques. The geophysical methods applied to the slope stability analysis are given in detail by Hack (2000) [7].

When we examine the geological units of Denizli and its surroundings stratigraphically, there is the Çine group at the bottom and the Kavaklıdere group above it. The Mesozoic (Jurrasic-Cretaceous) Bekilli group overlies the Paleozoic units. Cenozoic aged cover units unconformably cover the lower aged units. cover units; Eocene aged İnceler formation, Oligocene aged Akçay group, Miocene-Pliocene aged Denizli group, Plio-Quaternary aged Taşlıtepe group, Pleistocene aged Asartepe formation and Quaternary alluvium, which unconformably follow each other (Figure 1). Denizli and its surroundings are located at the intersection points of the Büyük Menderes, Gediz and Çürüksu grabens (Figure 1). Denizli basin is a 50 km long, 24 km wide NW-SE trending depression [8].

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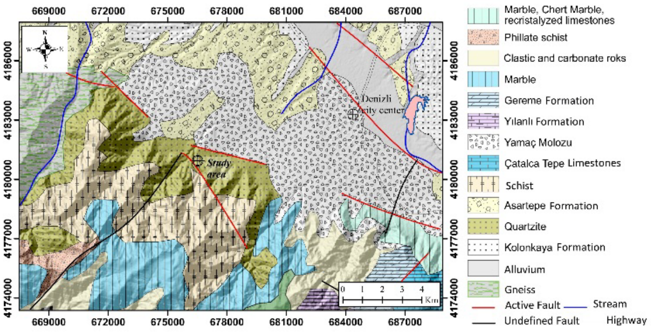

Figure 1. Simplified Geological Map of the Denizli Basin [8]

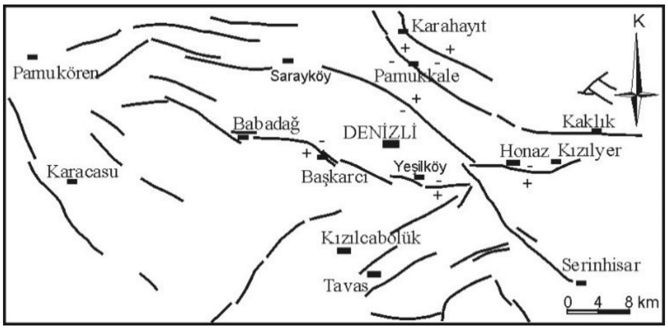

Figure 2. Faults in Denizli Province and its study area [9]

The faults mapped in and around Denizli in Figure 2 are generally dip-slip normal faults. Faults within the study area are secondary (secondary) normal faults that developed on the ceiling block of the main fault limiting the Denizli basin from the south. In some faults, where the fault plane can be observed, oblique-slip was observed in places. The locations of the faults, which cannot be traced in the closed areas due to young fill soils or construction, have been traced and mapped outside the study area around Gümüşler, Şemikler and Kumkısık in the west-southwest and around Eskihisar, Bozburun and Aktepe in the north [8].

2. Method

2.1. Creep

The very slow and continuous displacement of the superficial part of the slope is called a 'creep (slow flow)'. Slow flow can be observed in all kinds of materials. The mechanism of the movement can be defined as the particles on the ground absorbing water and moving upwards perpendicular to the slope, and when they dry, their volume decreases and descends vertically. While the movement is faster in water-saturated soils, it is slower in less-saturated soils. The amount of cripple depends on climatic conditions, slope, soil type, characteristics of the rocks and the degree of weathering of the material. The slow-flowing material is loose, rotten, highly weathered, and has rounded pieces of discrete materials in large quantities in the field (Figure 3-4).

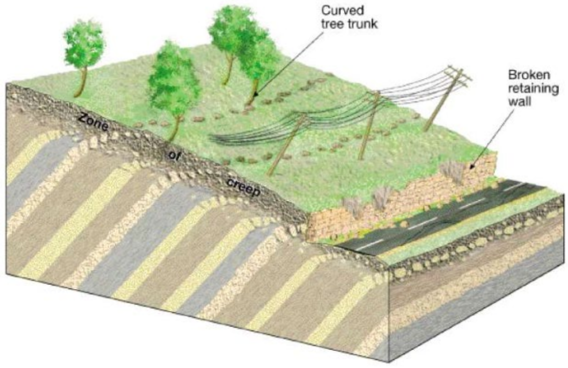

Figure 3. Soil or rock creep [10]

Figure 4. The trunks of the trees on the land were bent

Movements accelerate as a result of the presence of groundwater, seasonal conditions such as wetting and drying, the growth of plant roots and the carving of the soil by some animals. As the soil becomes saturated due to excessive precipitation, an increase in the amount of movement occurs.

2.2. MASW Method

In the study area, seismic refraction-MASW studies were carried out in order to determine the dynamic-elastic engineering parameters of the soils, layer thicknesses, and soil classes according to earthquake regulations. A total of 4 seismic fracture MASWs were made. In the seismic refraction measurement, hits were made from straight, middle and reverse points and the measurement was taken to see the depth of 30 m underground. Based on these measurements, bedding, underground velocity structure, dynamic-elastic engineering parameters of soils, soil classes, dominant soil vibration periods, soil amplifications, and lateral and vertical discontinuities in the soil were determined. Geophysical measurements were taken where they best represent the area. In the study area, 4 MASW Surface Wave measurements with 55 meters extension were made. In the MASW method, which is applied with 12 channels on a total of 4 profiles, geophone intervals of 5 m and offset of 10 m were selected and 4.5 Hz geophones were used. In MASW measurements, the sampling interval was chosen as 0.5 ms and the recording length as 1 ms. (Fig. 5).

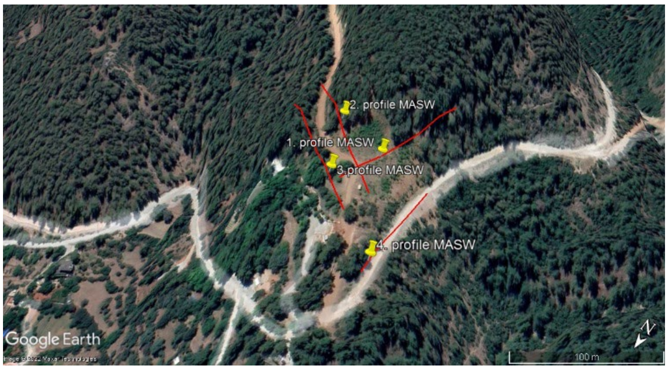

Figure 5. MASW lines

2.3. Interpretation

When we look at the sections in Figure 6, it is seen that the surface-weathered material gradually increases in the direction of flow in the general slope direction. When we examine the depth section, we can see two separate layers of 2 m between geophones and 22 m in depth along 55 m in the N-S direction. The speed of the first layer of these layers is 1427 m/sec, while the speed of the second layer is 2956 m/sec. The first layer, which is composed of relative infill and weathered material, reveals the defined interface with the slip surface obtained from the first two methods and is seen as a thicker layer on the left side of the profile. The contact line can also be interpreted as the slip surface separating the two layers.

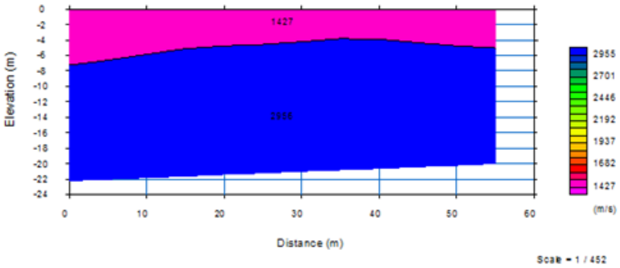

Figure 6. MASW section of the profile_1

When we examine the MASW-P2 depth section in Figure 7, we can see two separate layers of 2 m between geophones and 22 m in depth along 55 m in the N-S direction. The speed of the first layer of these layers is 1369 m/sec, while the speed of the second layer is 3054 m/sec. The first layer, which is composed of relative infill and weathered material, reveals the defined interface with the slip surface obtained from the first two methods and is seen as a thicker layer on the left side of the profile. The contact line can also be interpreted as the slip surface separating the two layers.

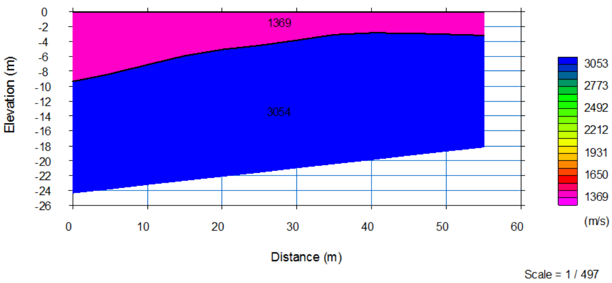

Figure 7. MASW section of the profile_2

When we examine the MASW-P3 depth section in Figure 8, we can see two separate layers of 2 m between geophones and 22 m in depth along 55 m in the N-S direction. While the speed of the first layer is 925 m/sec, the speed of the second layer is 3147 m/sec. The first layer, which consists of relative infill and weathered layers, is the interface obtained from the first two methods and defined by the slip surface, and it is seen as a thicker layer on the left edge of the profile. The contact-shaped line can also be interpreted as the slip surfaces separating the two layers.

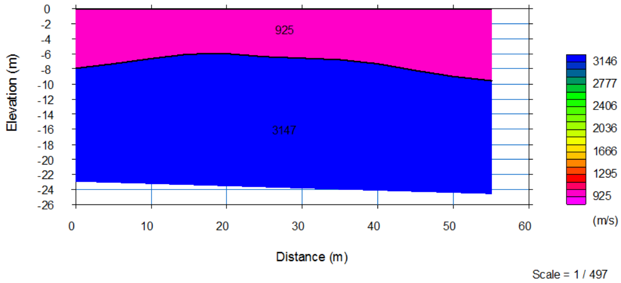

Figure 8. MASW section of the profile_3

When we examine the MASW-P4 depth section in Figure 9, we can see two separate layers of 2 m between geophones and 22 m in depth along 55 m in the N-S direction. The speed of the first layer of these layers is 1296 m/sec, while the speed of the second layer is 2572 m/sec. The first layer, which is composed of relative infill and weathered material, reveals the defined interface with the slip surface obtained from the first two methods and is seen as a thicker layer on the left side of the profile. The contact line can also be interpreted as the slip surface separating the two layers.

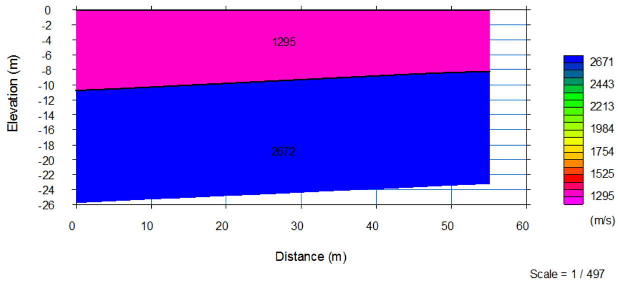

Figure 9. MASW section of the profile_4

3. Conclusions

This study, it was aimed to determine the mass movements in the landslide areas carried out in the Şirinköy District of Denizli Province Merkezefendi Municipality. As a result of the observations and geophysical methods in the study area, it was determined that slow flow occurred (Figure 10).

In the study area, the slope, direction and amount of slope of the slide were determined by making measurements from the ground. As a result of MASW measurements made in the study area, very important parameters were reached. At the same time, it was concluded that making geophysical measurements in landslide studies would provide more accurate results, would be cheap and practical, and it was confirmed that it would be easier to reach the result by using such regional studies. It has been determined that the studies carried out in landslide areas play a very important role in the trees, and it is thought that more accurate results will be obtained by adding the measurements made on the trees to such studies.

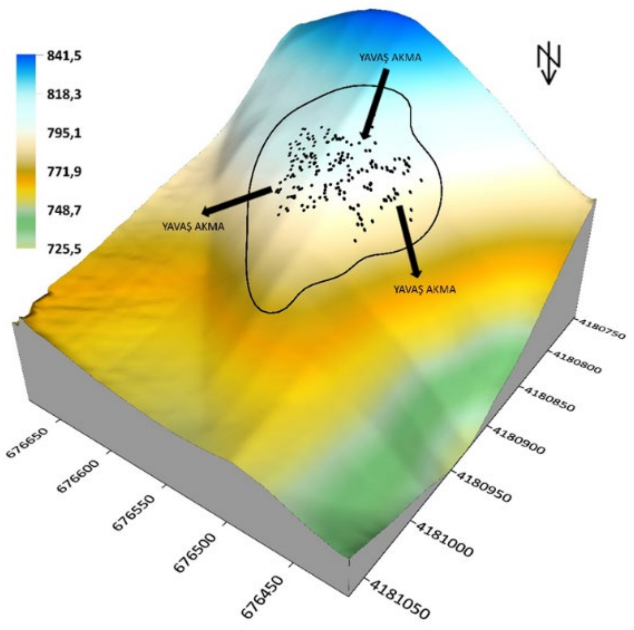

Figure 10. Simple to understand representation of which directions of slow flow on topographic map

The slope direction of the slow flow on the surface and the slope direction of the trees are exactly the edges of each other. In the Şirinköy neighbourhood, the slope direction of the ground is N, NW and NE. Depth sections of the animals were extracted from the MASW method, and the direction and dimensions of mass movement within the study area were aimed. The study area was reached to a depth of 20-30 m underground. Low and high-velocity zones are intended for MASW sections. It is understood that seismic velocities in these areas are lower than 910 m/s and it is observed that there are reflections from the limestone in the weathering and filling atmospheres in these services. It also corresponds to the weathering surfaces.

The organs in the study area are as follows; blocky limestone (it is relatively the component unit of the slip surface), smooth bedding, less weathered limestones, weathered limestone and filling soils determine the dimensions and that the slide will not show a stable structure on the slope.

It is aimed that the slip surface separating the two layers from each other by exiting the MASW sections is limestone expanded to the road around the weathering and filling. The profile width slope displays the surface weathered material gradually moving away from the flow direction. It has been determined that there are two layers in the underground sections and their velocities are targeted for each layer.

This study can be considered an interesting subject for those who are considering purchasing for similar purposes, as it is a rare geophysical study for this purpose.

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Declaration of Conflict of Interests

The authors declare that there is no conflict of interest. They have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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