

5-5 Estimation of Slope Stability

5-5-1 Expected Slope Hazards

In the Study Area, several types of slope hazards are expected. Typically, many cliffs are found where shallow landslides and rock falls occur. In areas with gentle slopes, landslides are expected due to ground motions related to earthquakes or rain after earthquakes (as landslides are found in several areas). Also debris flow is expected due to rainfall after earthquakes.

(1) Shallow landslides, rock falls

In the Study Area, perpendicular cutting slopes are found composed of Calcareous sandstones or schists. These rocks are strong enough for perpendicular cutting at normal times but during heavy rain or earthquake shock the vertical cutting slope in some areas will collapse (Photo 5-1). In the Study Area, high vertical cutting slopes exist and in some cases, houses are built at the edge (Photo 5-2). Therefore, even shallow landslides can result in the possibility of fatalities.

In addition, some of the cliffs include large rocks (Photo 5-3, Photo 5-4) resulting in rock fall hazards. In Photo 5-4, a dip slope structure is found, which implies the rock crack and slope inclination run in the same direction.

The unstable layer is difficult to estimate although Photo 5-5 and Photo 5-6 indicate its depth is less than 2 m, suggesting it has a possibility of collapsing.

(2) Landslides

At No.18 drilling point, a landslide was found with Photo 5-7, Photo 5-8 and Photo 5-9 showing the damage due to its occurrence. An earthquake has a possibility of pushing the landslide out. Also, if earthquake motion is sufficiently strong there is a possibility that a new landslide will be produced.

(3) Debris flow

If rain occurs after an earthquake, there is a high potential for debris flow to occur. In several slope areas, the rock strength can also become weak after an earthquake. Therefore, lower intensity rainfall will produce the debris flows than under normal rainfall conditions. The debris flow material is readily found along the river (Photo 5-13). Photo 5-14 shows debris flow in 2001.

Uncrushed rocks are also found at the slope along the highway (Photo 5-15, Photo 5-16), reflecting a flow similar to an avalanche phenomenon. The onset of this type of flow is immediate and will extend some distance. Overall, possible locations of such flows in the near future are difficult to predict.



Photo 5-1 Shallow Landslide



Photo 5-2 Houses at the Edge of Cutting



Photo 5-3 Slope Including Rock in the Wall



Photo 5-4 Dip Slope Structure



Photo 5-5 Weak Layer within 2 m



Photo 5-6 Weak Layer within 2 m



Photo 5-7 Window Broken by Landslide

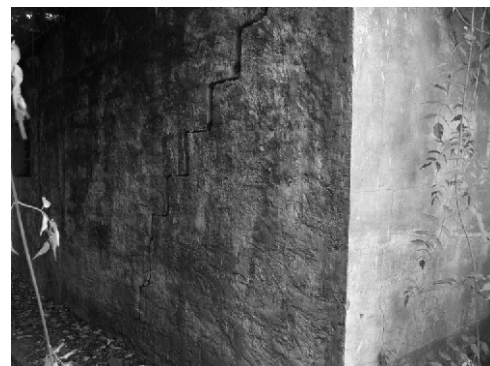


Photo 5-8 Wall Broken by Landslide



Photo 5-9 Wall Broken by Landslide



Photo 5-10 Typically Gentle Slope

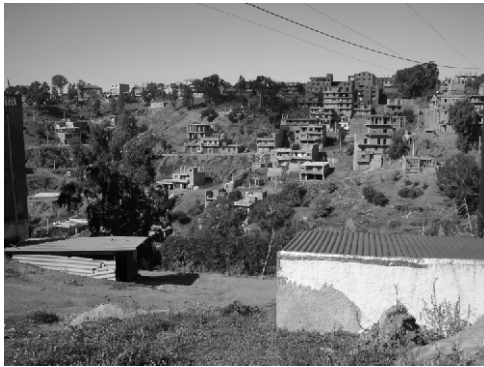


Photo 5-11 House on a Gentle Slope



Photo 5-12 Gentle Slope, Marine Terrace



Photo 5-13 Unstable Soils along the River



Photo 5-14 Debris Flow 2001(provided by Assia)



Photo 5-15 Slope along the Highway



Photo 5-16 Trace of Flow without Rock Crushing