The Effect of Landslides in Konaktepe Dam and HEPP Project (Tunceli-TURKEY) Design

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ABSTRACT

Study area locates on the Munzur River, city of Tunceli. Many of the paleo and active landslides were determined during the geological mapping process for the construction of Konaktepe Dam and Hydroelectric Power Station. One of the paleo-landslide area that has ability to affect the status of the project negatively was found approximately 1100 m upstream of the Dam location which is at the east side of Munzur River and across the Torunoba Village. The paleo-landslide material that was identified during this study was investigated in terms of whether or not it would slide depending on the impoundment of water to the dam and its possible affects to the project in case of sliding. In the abstract, refrain from mentioning the preliminaries and generalities, and briefly mention the study problem and its objectives, the basis of work, and the success rate of this study, based on the results of the work.

Keywords: Konaktepe Dam, landslides, geotechnic

Introduction

Study area locates on the Munzur River, city of Tunceli. Many of the paleo and active landslides were determined during the geological mapping process for the construction of Konaktepe Dam and Hydroelectric Power Station. One of the paleo-landslide area that has ability to affect the status of the project negatively was found approximately 1100 m upstream of the Dam location which is at the east side of Munzur River and across the Torunoba Village. The paleo-landslide material that was identified during this study was investigated in terms of whether or not it would slide depending on the impoundment of water to the dam and its possible affects to the project in case of sliding. Project properties are given at the Table 1 below.

Table 1. Project properties

River	Munzur
Type of Dam	Embankment with clay core
Crest altitude	1241 m
Height from the Thalweg	116 m
Height from the foundation	121 m
Crest Length	437 m
Crest Width	10 m
Energy Tunnel	13 800 m
Annual Total Energy	583 GWh

1. Geology

Eosen aged Konaktepe Formation that consist of agglomerate underlies the Project area. Middle Miocene aged Torunoba Formation which consist of sandstone, shale, siltstone, limestone and conglomerate overlays that formation with unconformity. Quaternary aged debris and alluvium units overlay the Torunoba formation (Figure 1). Landslide area locates at Torunoba formation. Project area is located within the 1. Degree Earthquake Zone (DSİ, 2004).

2. Field and Laboratory Studies

Landslide area extends up from 1490 m altitude to 1140 m where the riverbed is. Slope is an average of 20^0 inclined where sharp steepness were formed in some areas after landslides. There are so many paleo-landslides with different sizes available in this area. They are seen as the alternation of steeper slopes in landslide crown with bench and flat terraces (Photo 1).

Kört hamlet locates over one of these big terraces. Local tension cracks and bending of plants in some places are observed at the steepness that over the terraces. Effective slide is seen at river level, namely at the toe of the landslide.

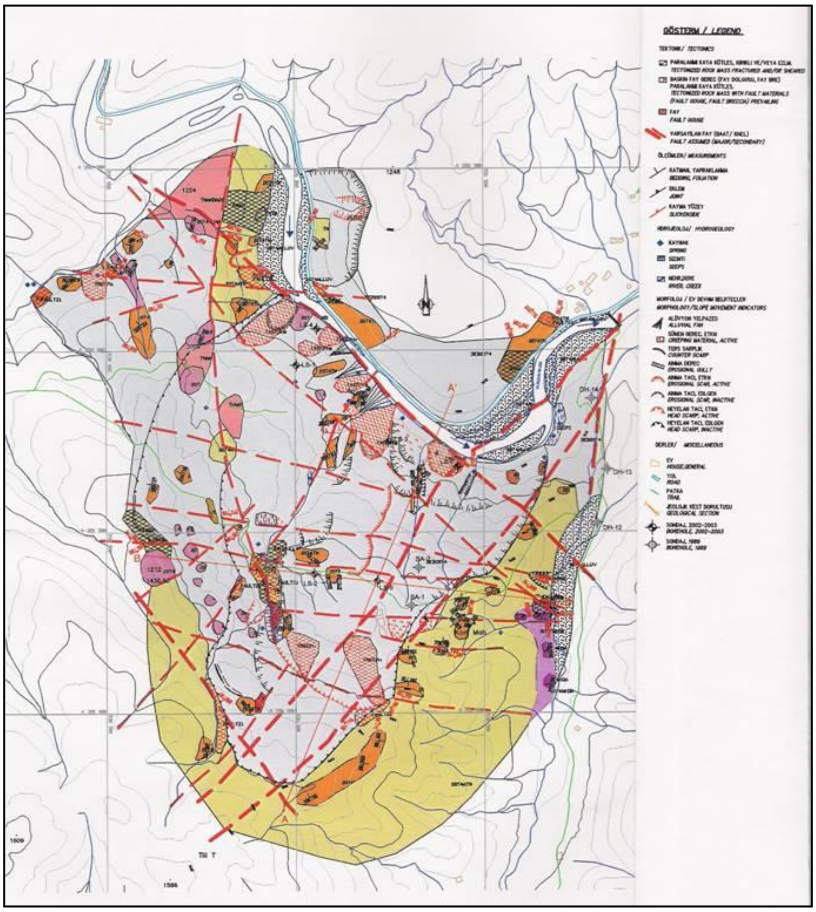
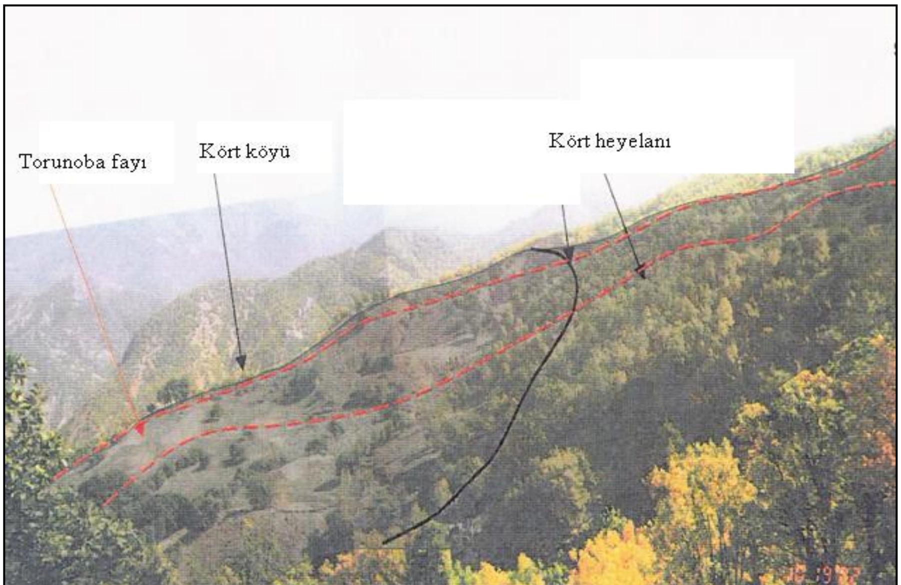


Figure 1. Geological map of the Landslide area



Photograph 1. Landslide view from upstream of river

Study area consists of many different discontinuities in terms of dips and strikes. As a result of intersection of these discontinuities, wedges toward the downstream and river come into existence. This would facilitate a movement that may occur. Water outlets from various places are available in the area.

Landslide area is divided in to two pieces as a “Area A” and “Area B”. Area A is approximately 440 000 m^2 whereas Area B is 300 000 m^2. These two areas are separated from each other by a deep river (Figure 2).

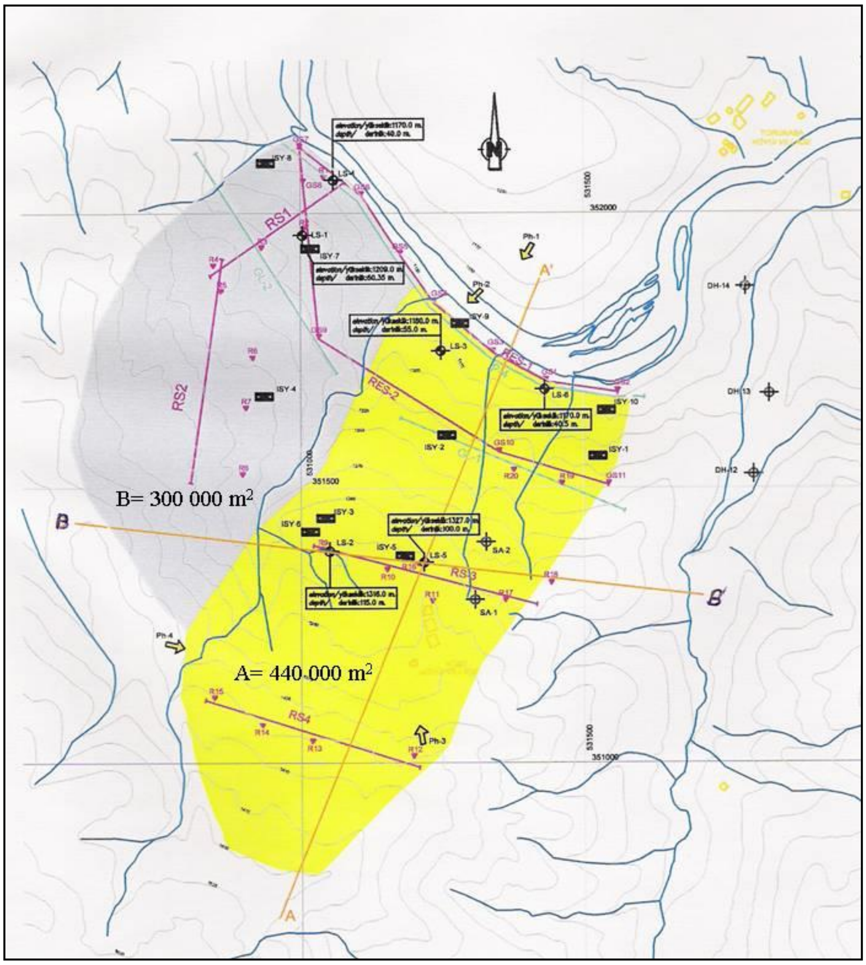


Figure 2. Geotechnical map of the landslide area

6 boreholes were drilled for core sampling and geophysical explorations were carried out in this study. 4 inclinometer were placed in to the boreholes. Laboratory experiments were performed on the samples taken from boreholes. Accordingly, units were classified and geotechnical parameters obtained (Table 2). Geological Cross-sections were drawn by evaluation of these data (Figure 3).

Table 2. Classification of rocks and geotechnical properties

	Description	γ (kN/m^3)	ϕ^0	c (MPa)
TN-0	Debris	19	26	0.075
TN-1	Displaces Rock Mass	20.5	30	0.180
TN-2	In-situ Rocks affected by excessive tectonism	21.5	20	0.150
TN-3	In-situ Rocks affected by partial tectonism	23.5	32	0.380
SL	Shear Plane	20	18	0.030

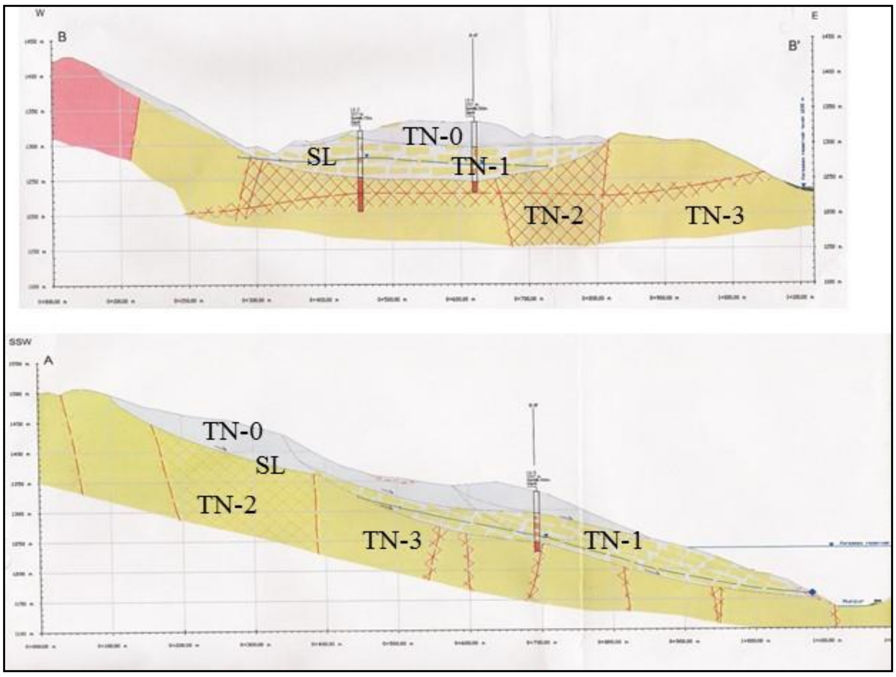


Figure 3. Geological Cross-sections

3. Slope Stability Analyses

As results of analyses, Shear plane was defined precisely at almost 12.50 m depth in the upper parts of Torunoba Formation where the unconsolidated debris was present. In a worst case scenario a deep failure may take place at approximately 80 m depth. In case of failure of the slope, Tsunami effect over dam body, current situation, fully filled reservoir, rapid drawdown and adding retaining wall to the toe situations were investigated. Accordingly, Slope stability analyses were performed.

Analyses were performed in Rocscience "Slide 5" software by using "Simplified Bishop Method" at static and dynamic conditions separately. Peak ground acceleration value was determined as 0.43g by considering severe Pülümür and Bingöl Earthquakes design. In terms of conceptual design 35% of that value was chosen which is A_0= 0.15g (Figure 4).

It is estimated that landslide area is stable for all cases in the static conditions, whereas in dynamic conditions, Factor of Safety value converges or drops below to 1 in case of deep slip.

In a worst case scenario such as earthquake, increased pore water pressure etc. approximately 1 000 000 m^3 material with 12.50 m thickness and 0.25 dynamic coefficient of friction of 100 interval was reached 12-17 m/s velocity before slide in to the dam reservoir. In this case wave height was estimated as 2.70 m by using Slingerland and Voight (1979) method.

Due to toe distance between two slopes is 100 m away; the sudden mass movement is prevented for medium fast (Varnes, 1978). Accordingly, with the assumption of a safe hydraulic friction coefficient, the height of the vertical wave length at 1235.00m altitude for the stable water was reached 5.40m at the level upstream slope. That means when the slope angle was chosen as 2.2 horizontal / 1 vertical, water level would rise up to 1240.40 m altitude. As a result of this, crest altitude elevated to 1241.00 m with margin of air. The area will be kept under the control during construction by frequent measurements.

Contribution of building a retaining wall to the stability of landslide's toe has been determined to be minimal. Building wall only reduces the probability of sliding along the toe and forces slip circles to be appeared at the upper part of the slope, hence the volume of displaced material decrease.

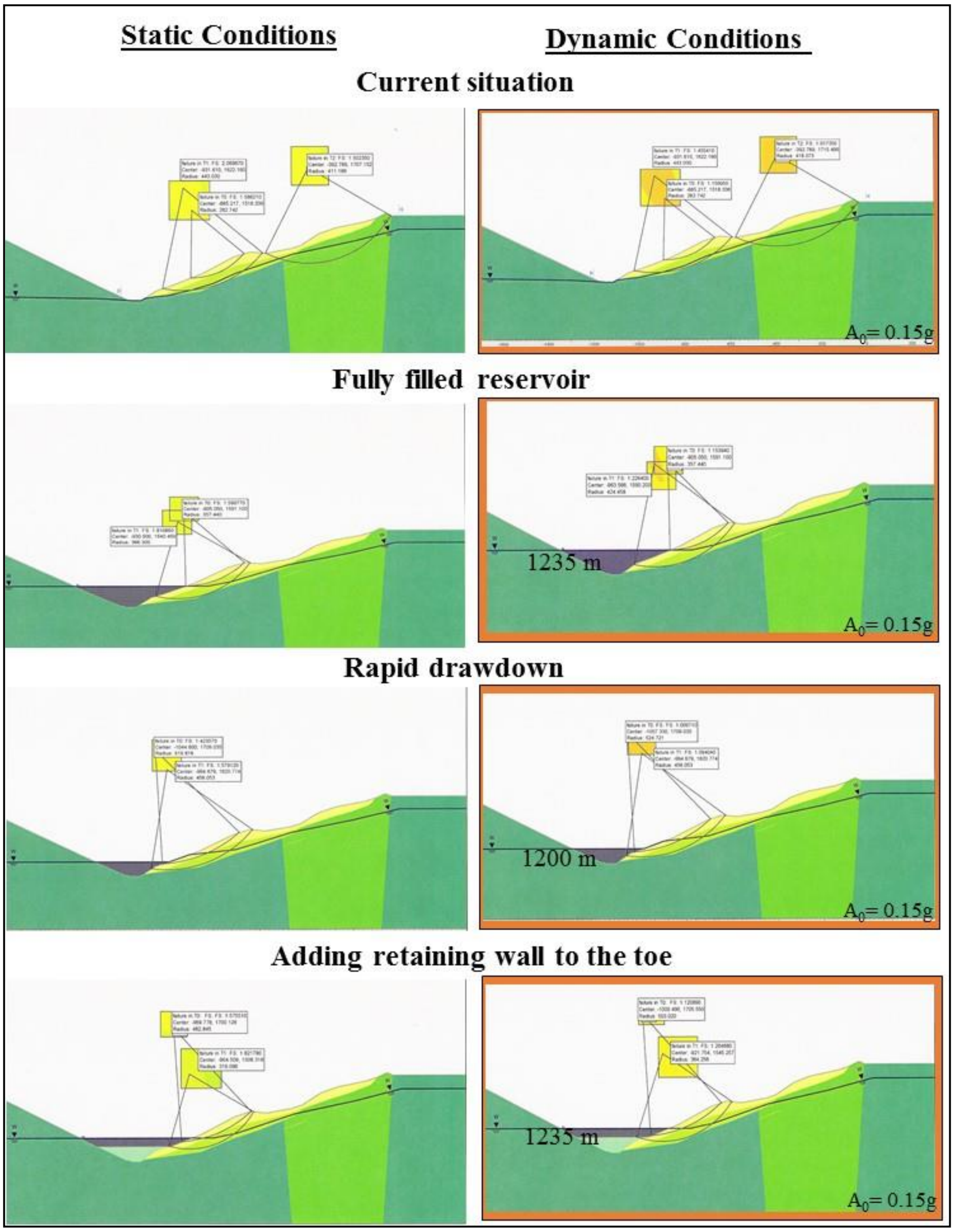


Figure 4. Slope Stability Analyses

4. Results

Shallow or deep failure is unlikely to be for the static condition. In case of sudden drawdown and fully filled reservoir condition, local and shallow failures are possible. In case of that type of failure, it was determined that displaced material is likely to be less than 250 000 m^3 and wouldn't affect the project status negatively.

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Slope stability should continuously be observed by inclinometers placed in 4 different boreholes during the construction stage.

At the planning and final stages of hydraulic structures, sufficient geological and geotechnical works should be done at construction sites and reservoir area, and their possible impacts on the project should be identified.

References

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The Author

Ayhan KOÇBAY graduated 1991 from the Ankara University Science Faculty Geological Engineering Department. He worked between 1992-2002 years as research assistant in Ankara University. He completed in 1994 master (Ms.C) and in 2002 his doctorate (Ph.D.) education. In 2002 he crosses to General Directorate of State Hydraulic Works Geotechnical Services and Groundwater Department. He is expert in engineering geology, geotechnical works, rock mechanic and soil mechanical subjects. He has in several publicized academically journals written; 11 international, 48 national and 3 lesson notes which are covering rock mechanical, soil mechanical and geotechnical subjects.