A 60 m high Geogrid Reinforced Steep Slope for the Stabilization of a Landslide in Northern Italy

Cazzuffi, D.[1], Recalcati, P.[2]

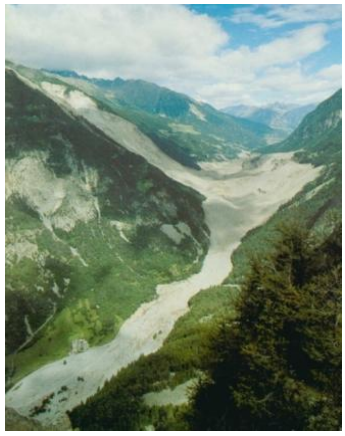
[1] CESI SpA, Milano (MI) - Italy; daniele.cazzuffi@cesi.it
[2] TENAX SpA, Viganò (LC), Italy; piergiorgio.recalcati@tenax.net

DESCRIPTION

In July 1987, a major landslide occurred in Northern Italy that required significant remediation work. This paper presents the event details as well as the mitigation solutions that took place. More than 35-45 million cubic meters of rock avalanche collapsed, falling from the right hand side of the valley into the river bed, 1200 m below, and running up about 300 m on the opposite side. The landslide destroyed some villages directly underneath, while a catastrophic water and debris wave hit the villages located up to 1.0 km upstream along the valley. The landslide body created a natural dam 80 m high and 2.0 km long, completely closing the valley and thus creating an artificial lake behind it. The left hand side of the valley, not hit directly by the landslide, was covered by debris. The main goal that guided the design choices, was restoration of the valley's original shape before the landslide. It was necessary to reach the bottom of the river and excavate the deposited debris as much as possible and to the depth that was safely achievable, and to remove the debris on the left side of the valley. In order to avoid instabilities, the left hand side was reconstructed using temporary anchored sheet pile walls and soil reinforced slopes. The whole slope was reconstructed with 6 geogrid-reinforced slopes, each is 10 m high, separated by berms, totaling a height of 60 m. The slope inclination was 60° with a roadway over the base slope.

The type of geosynthetics used for slope reinforcement were uni-axial extruded HDPE geogrids, the peak tensile strength ranged from 45 to 90 kN/m; the spacing was kept constant and equal to 700 mm. Wrap around technique with sacrificial welded wire steel mesh formworks at the face was used. The excavated material, consisting of gravel in a sandy-gravel matrix with negligible fines content, was used as a fill material after proper sieving using a site screen to limit the maximum grain size to 150 mm.

This is probably the tallest structure ever designed and constructed in Europe and one of the tallest in the world. The whole project (excavation and reconstruction) started in 2010 and finished in 2012. During 2013, the slopes were attacked by fire; an inspection of the site confirmed the slope stability was not compromised and additional testing on exhumed geogrids confirmed that also the geosynthetics didn't exhibit any substantial damage. In addition to the description of the event and site geology, the presentation addresses the design and construction aspects, as well as the inspection and testing operations that were adopted following the fire.

(a)


b) c)


d) e)

Figure – a) aerial view before and after the landslide; b-c) construction phase; d) fire damage to the slope; e) present condition after assessing the fire impact.