SYCONS

SPECIAL ENGINEERING

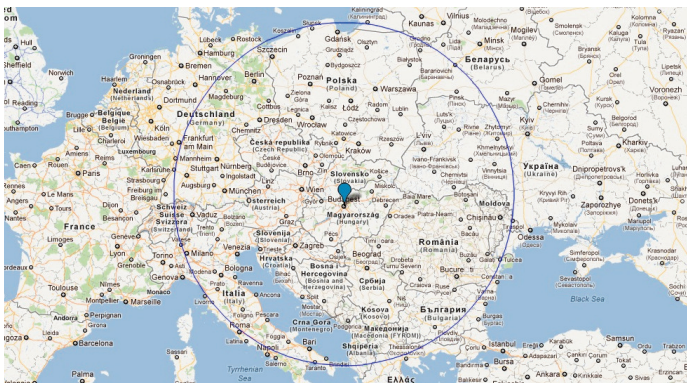
STABILIZATION AND PREVENTION OF WATER TRIGGERED LANDSLIDES

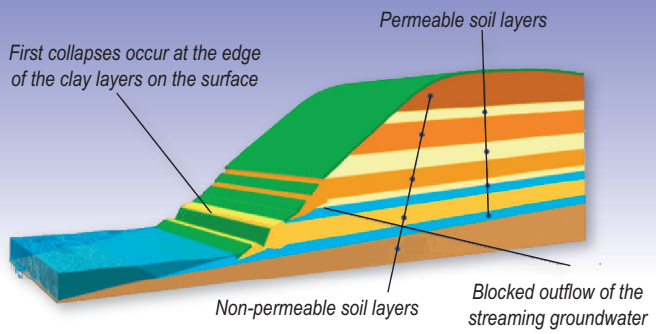
The big majority of the water triggered landslides could happen at the areas, where permeable (sand, gravel), semi-permeable (fine sand, silt), semi watertight (sand or silt with high clay content) and watertight (clay) soil layers had been settled above each other in a sandwich-like soil structure in a light slope (over 4-5%) to deeper valleys, rivers, lakes, or to the sea.
These type of landslides are tipically triggered by the dramatic changes in the subsurface stream of the groundwater thus the significant rise of the groundwater level. The increasing active sliding forces (caused by the rising groundwater table and increasing hydrostatic pressure behind the shearing surface) and the decrasing passive friction forces of the impregnated clay layers result in a slide of the different layers on each other.

The first step of stabilizing these areas is to create a free outflow/discharge possibility for the groundwater volume collected behind the dawn-falling surface.
We solve this problem with a relatively deep and long special drainage system laid on the surface of the bottom watertight layer with HDD (Horizontal Directional Drilling) technology using special drainage pipes that create a natural filter body around themselves in silty/sandy soils with the help of the inflow water stream). In case of multiple permeable or semi-permeable soil layers we also drill vertical filter piles (filled with sand or fine gravel) to collect the congested water through the whole layer structure. These can later be operated as watertable control wells to monitor the long-term effects of the drainage system.

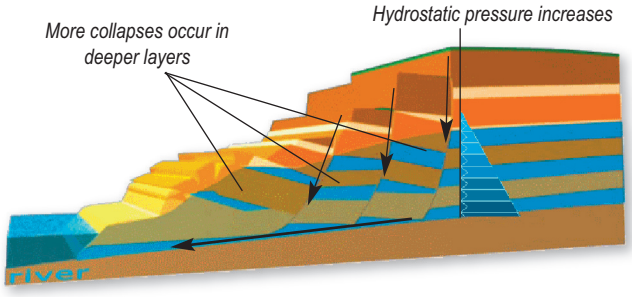
In case dewatering itself is not sufficient to achieve the desired safety factor, a part of the slipped soil volume can be removed and a reinforced soil body can be constructed instead as an invisible soil retaining wall. The reinforcement can be solved with geosynthetics or hot galvanized wire mesh with soil anchors if needed for further support.
In case it is not required to reconstruct the original slope conditions, the whole bank can be reshaped with approprite inclinations and shoulders, supported by a reinforced concrete pile system as a special form of soil nailing if necessary. The surface shall be also protected to prevent the further unnecessary infiltration of the precipitation. In case of intense water level fluctuation it is also recommended to build a protection system against wave, flood or tidal erosion.

Our complete range of equipment and several years of experience in stabilizing these kinds of soil movements enable us to provide effective, full service solutions of prevention or reconstruction in cases of water triggered landslides within **800 kilometers of distance from Hungary**.

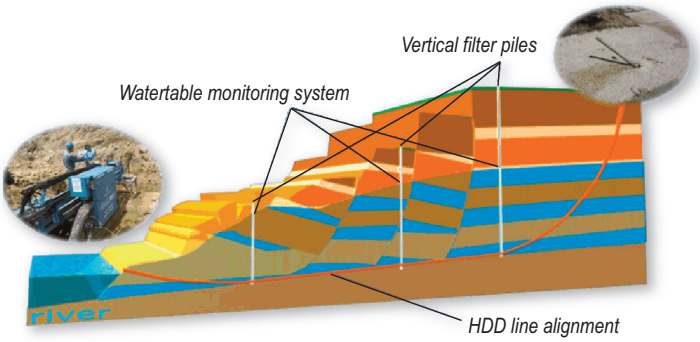




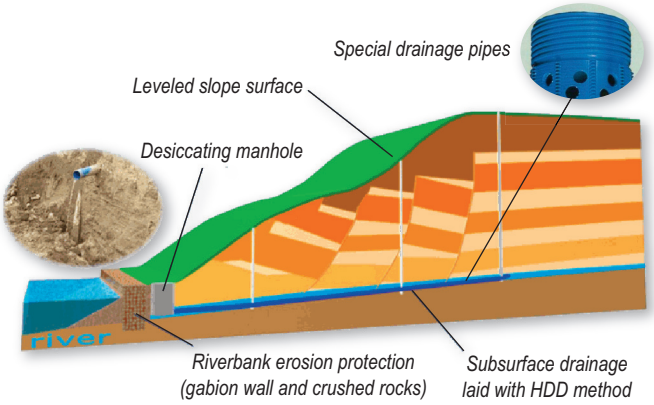
1. Sketch of an embankment cross section showing the layer structure and the first collapses on the edge of the bank



2. The hydrostatic pressure behind the shearing surfaces enhances the active horizontal forces on the non-permeable layers causing (multiple) slides



3. Vertical filter piles are drilled through the layers, connected by special drainage pipes laid with HDD method on the surface of the bottom watertight layer



4. Erosion protection and slope surface finished, drainage and monitoring systems installed

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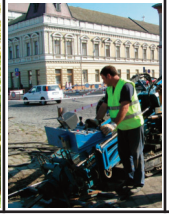
LANDSLIDE PREVENTION

REFERENCES FROM THE PAST YEARS

The following is a list with a few examples of landslide stabilization related projects realized in the last 10 years:

Short description	Location	Main used methods	Main dimensions	Year
Danube riverbank stabilization in multiple phases	Ercsi, Hungary	Subsurface drainage system, soil reinforcement (anchors), CFA piles, stone ribs, gabion retaining/protective wall	vertical filter piles: 663 m (Ø300 mm) horizontal drainage pipes: 572 m (DN50)	2001 2003 2012
				
Danube riverbank stabilization in multiple phases	Rácalmás, Hungary	Subsurface drainage system, CFA piles, stone ribs, gabion retaining/protective walls	vertical filter piles: 912 m (Ø200 mm), 1200 m (Ø400 mm) horizontal drainage pipes: 3030 m (DN50)	2003 2011
				
Danube riverbank stabilization	Dunaújváros, Hungary	Subsurface drainage system, soil reinforcement (anchors), CFA piles, stone ribs	vertical filter piles: 104 m (Ø400 mm), horizontal drainage pipes: 230 m (DN50)	2010
				
Danube riverbank experimental groundwater drainage	Dunaújváros, Hungary	Subsurface drainage (HDD) and monitoring system	horizontal drainage pipes: 400 m (DN50)	2010
				
Riverbank stabilization, groundwater level decrease	Baja, Hungary	Subsurface drainage system	horizontal drainage pipes: 1612 m (DN50)	2005
				

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