



## **Integrated mitigation measures on large slow moving earth slides in the Province of Reggio Emilia (Northern Apennines, Italy)**

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Several large slow moving earth slides are found in the sector of the Northern Apennines falling into Reggio Emilia Province about 70 km west of Bologna (Northern Italy). Some of these landslides have resumed activity in the last years, and are threatening some hamlets and important roads. The mitigation of the induced risk is carried by dedicated public offices following an integrated process in which the gaining of geological and geotechnical knowledge about the phenomenon, goes alongside with the design of structural mitigation. Identification, characterization and monitoring of critical areas is carried out with a broad range of underground investigation methods and borehole or surface instruments. In some cases, these devices are also used to observe the evolution of events precursors, so to allow a non-automated early warning activity to be carried out. The most frequently adopted structural measures are subsurface and deep drainage systems that can be either trenches, large (4-5 m) or medium (1.5 m) diameter well shields, sub-horizontal drains. All these systems operate on the long term by gravity, while pumping is only used in the construction phase. In order to promote a rapid runoff and improve slope stability the drained water is conveyed to an adequate pattern of diversion ditches and collectors linked to the streams that border the landslide bodies. The protection of the deep drainage systems for the time needed to actually obtain stabilization effects is searched with deep-founded pile walls. Reinforcement of pile walls is guaranteed by tied-back anchors that are installed and tensioned against the face of the wall. The walls act partially as retention structures, but in particular are large reaction plate for rock anchors, that distribute the anchor

loads into the rock mass. The presentation will be centered on some relevant case studies where this integrated approach has been fully exploited.