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Time Domain Reflectometry (TDR) monitoring system for deep seated landslides

J. Singer, K. Thuro, and J. Festl
Chair of Engineering Geology, Technische Universität München, Munich, Germany (singer@tum.de)

In the 1980s Time Domain Reflectometry (TDR) has been introduced as a subsurface deformation monitoring system in boreholes, which allows identifying and localizing discrete deformation zones with high accuracy. While TDR offers several advantages as e.g. low costs and the possibility to continuously monitor deformation along the complete borehole,TDR was not used widespread due to the fact that the amount of deformation sometimes could not be determined accurately and in some cases no deformation was detected at all.

By the definition of calibrated installation standards and the usage of advanced signal analysis methods, it is possible to overcome this and a reliable quantification of deformation using TDR is possible. In the ongoing research the attempt is made to define different TDR measuring system configurations (measuring cable and grout combinations), where each is designated for a specific geological environment. These set-ups are then calibrated in laboratory shear tests and finally tested in field, if possible by comparing them with inclinometer measurements. To date monitoring data of three different deep seated landslides in the European Alps (Gschliefgraben, Aggenalm and Triesenberg) have been collected. The field test results clearly show that the new TDR system can fulfill the expectations and the deformation can be determined with sub-centimeter accuracy if one basic prerequisite concerning the mode of deformation is fulfilled: TDR can only be used when localized shear deformation is present.

Since TDR data easily can be acquired continuously as well as remotely, it is possible to use a TDR measuring system as a valuable part of a monitoring system for landslide early warning. Since 2008 such a monitoring system is in operation at the Aggenalm landslide, where the TDR subsurface deformation measurements supplement the information on surface deformation from geotechnical and geodetic measuring systems to a 3D early warning system for instable slopes.