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An Optical Fiber Based Early Warning System for Large Landslides

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The objective of this study is to utilize a monitoring and early warning station that can be applicable to any type of mass movement in order to minimize life and property losses. For this purpose, an optical fiber system was preferred due to its continuous data gathering capability and feasibility for field conditions. Moreover, optical fiber systems are more reliable compared to many of the other methods on account of their spatial resolution advantage. The landslide early warning station is composed of an optical fiber system, a piezometer and an accelerometer. This station can be controlled remotely and it is capable of alarming the users by e-mail and SMS messages. The optical fiber system utilized in the project is composed of optical fiber cables and a device called BOTDA (Brillouin Optical Time Domain Analyzer). This system has a 0.5 m spatial resolution for a fiber length of 1 km. The optical fiber system detects mass movement in terms of strain which results from the changes on the cable by measuring the sent and backscattered light generated by the BOTDA. Then, the strain values are converted to displacement.
In the first stage, the optical fiber system was studied in the laboratory with a small scale landslide model (2 m x 3 m). According to the results obtained from the laboratory experiments, 1500 $\mu\varepsilon$ corresponded to a deformation of 100 mm. After the laboratory studies have been completed, the station was transported to a 50 m wide and 40 m long large scale landslide area in Kocaeli, one of the high seismic areas of Turkey. In the study, one-year period strain values of the landslide gathered by the optical fiber system was evaluated together with the hydrological and hydrogeological effects (i.e. precipitation, groundwater level and pore water pressure) and seismic activity in order to study the effect of the triggering factors and to increase the sensitivity of the system. After the evaluation of these factors, a threshold strain value which is the deformation that is capable to cause failure was determined and the monitoring system was converted to an early warning system. The results support the fact that the deformation is directly related with precipitation, groundwater level and pore water pressure. Moreover, seismic activity influences the deformation as a secondary effect. This study revealed that optical fiber systems are reliable and well-suited for developing early warning systems of deformation related engineering applications such as landslides.