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Transport infrastructure surveillance: monitoring of land slides, quick clay, rock slides, avalanches and bridge oscillations using an optical displacement monitoring system.

Jon Kristian Hagene (1) and Magnus Pedersen Lohne (2)

(1) Norsk Elektro Optikk AS, Lørenskog, Norway (jonkr@neo.no, +4767974900), (2) Norsk Elektro Optikk AS, Lørenskog, Norway (magnus@neo.no, +4767974900)

An optical displacement monitoring system, "NIODIM", is being developed by Norsk Elektro Optikk in the framework of the activities of the project "Integrated System for Transport Infrastructure surveillance and Monitoring by Electromagnetic Sensing" (ISTIMES), funded in the 7th Framework Programme (FP7/2007-2013).

Originally the optical displacement monitoring system was designed to detect relatively slow events like quick clay, land slides, rock slides and avalanches, but a prototype has recently also been successfully tested for impact and oscillations monitoring of bridge elements in the French Alps. These tests were performed in cooperation with other ISTIMES partners at the test facilities of Laboratoire Central des Ponts et Chaussées (LCPC) in Montagnole, France.

The system is based on one or more "reference points", an industrial grade camera and a compact computer system which processes the camera images in real time. The system is designed for outdoor use. The reference points could be light emitting diodes. The reference points will be mounted on objects or areas susceptible to move while the camera typically will be placed on firm ground. The computer system will detect the position of the reference points in each acquired image. In the normal case everything is stable and the reference point will remain in the same location both on the ground and in the image. However, if a landslide is in the progress the reference point starts to move and this will also be registered in the image.

Based on the geometry of the set-up, the camera sensor specifications and the focal length of the lens system it is possible to measure the actual displacement of the reference points based on the image data. Different thresholds can be set in the system enabling warnings for smaller displacements and alarms for larger displacements. The optical displacement monitoring system is normally a part of the overall ISTIMES system, but can operate as a standalone system. It is also possible to let the optical displacement monitoring system be part of the ISTIMES system and at the same time be a locally managed system making local decisions. Such local decisions could be to stop traffic if an alarm situation occur.

The optical displacement monitoring system was tested in the facilities of LCPC in Montagnole during an ISTIMES test campaign in October 2010. A steel reinforced concrete beam similar to ones used in bridges was mounted below a crane capable of dropping steel balls of 2.5 and 10 tonnes onto the beam. The 2.5 tonnes steel ball was dropped directly onto the concrete beam from different heights and the optical displacement monitoring system was mounted to measure the deflection and the following damped oscillations of the beam. The system successfully registered the deflection as well as the oscillations even though the beam movement was quicker than the events the system originally was intended for.

The measurement principle is relatively robust and will work even in rain and snow as long as some simple design details are added for all season outdoor use. This optical displacement monitoring system can increase safety for users of roads and railways at a relatively low cost and in a shorter time frame than other more extensive solutions like building tunnels or doing other more complex operations permanently eliminating potential risks.

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