INTRODUCTION

The primary goal of field monitoring was to measure the variation of shear wave velocity with displacement rates in a real, active earthflow. Mainant et al. detected a decrease of Vs ten days before the reactivation of a huge earthflow. This was explained by the fact that, during the solid-to-fluid transition, the material loses its rigidity and the void index and the water content increase, according the Vs decrease. It is possible to imaging that it is very difficult to detect a similar result. So we are trying to detect an increase of Vs over time, related to the material’s consolidation and the decrease of the water content. The data collected with the ReMi-MAW acquisitions will be related to all the data from the wire extensometers and the rain gauges, in order to verified a relationship between the Vs and the displacement rate.

We are also working on some lab tests on clay samples. We bought a triaxial cell modified with piezoelectric elements (binder elements), in order to study the variability of shear wave velocity at different void index. With these experiments we expect to improve our understanding about earthflows dynamics and solid-to-fluid transition.

OBJECTIVES

The study of the dynamic behavior of earthflows through the analysis of shear wave velocity in the landslide’s body.

MATERIALS & METHODS

I conducted periodic ReMi-MAW campaigns to assess the temporal variation of shear velocity for several landslides that were recently reactivated. I carried out acquisitions inside the landslide bodies and outside, in order to define the different value of Vs and monitoring the Vs over time. I used six geophones at 4.5 Hz, with a 2 meters distance. All the ReMi-MAW acquisitions were conducted with the Soluay - Micromed array and all the data were elaborated with the Software Grilla (Micromed). In order to obtain the continue variation of the shear wave velocity, we installed two fixed monitoring systems on active earthflows. Pricie monitoring devices were needed to this purpose since the expected variations in shear velocity were presumably small. At the beginning I performed field tests using 10Hz and 4.5Hz geophones, and I observed that the latter performs better for recording very low seismic noise. Then I built a signal amplifier by modifying a circuit designed by Rick Lakhaim (USGS-CVGS) for debris flow monitoring. The amplifier employs a 1000 Ohm resistor in order to amplify the signal x100 and provide a reference voltage of 1.2 Volt. All the equipment was thoroughly tested in the lab before field deployment. So far myself and my research group installed two monitoring systems on two active earthflows in the Northern Apennines of Italy: the first one at Silla (BO), and the second one at Montevicchio (FC).

Each monitoring system consists of a solar Panel, a CR1000 datalogger (Campbell Scientific), a GPRS communication system, a flash memory drive (SD card) to store data on site, a charge controller STEC SOL502 88F, and four 4.5Hz geophones to record the ambient seismic noise. Monitoring systems are designed to simulate a continuous MASW (Multi-channel Analysis of Surface Waves) survey. These systems are integrated with other monitoring instruments, like rain gauges, piezometers and wire extensometers.

RESULTS

From January 2014 to February 2015 I carried out numerous ReMi-MAW surveys to characterize several active earthflows in the Emilia-Romagna Apennines, I did these measures both inside and outside the landslide’s bodies, usually during the first ten days after the reactivation. At first, these measures indicate low shear waves velocity inside the landslide and high velocity outside. This is due to the different consistence of the materials and to the different water content. Then I repeated the measures over time in the same places on the same landslide, in order to detect the variability of Vs over time in correlations with the landslide’s movements.

Now, I am going to show you some of my results from the Silla complex landslide and the Montevicchio earthflow.

- The Montevicchio (Forlì-Cesena, North of Italy) earthflow was reactivated the 1st of February 2014 (estimated volume of 240,000 m³), and increased the movement’s velocity around the 7th of February 2014, after intense precipitations. Analyzing the data collected inside the landslide’s body, I observed an increase of Vs over time, due to the decrease of landslide velocity;

- The Silla (Bologna, North of Italy) complex landslide reactivated the 10th of February 2014 (estimated volume of 900,000 m³), and moved downwards with a maximum velocity in the order of several m/hour. Studying the data, it is possible to notice how the Vs increase over time only in the lower portion of the landslide. In fact the upper portion is still active, so the Vs remained unchanged over time.

CONCLUSIONS

• The measures inside the landslide’s bodies are different from the measures taken outside;
• The measures taken outside the landslide’s body do not show a significant Vs variability, because the material are not involved in the landslide’s movements;
• The ReMi-MAW acquisitions taken inside the landslide’s body show that the variation of the shear wave velocity with time is related to the movements of the landslides and to the different consistence of the materials.

Therefore by continuously measuring the ambient seismic noise in our two monitored landslides, we expect to improve our understanding about earthflows dynamics and solid-to-fluid transition. In fact the next step will be to try to find a relationship between the Vs variation, the displacement rate and the precipitation.

After all we would like to compare the results taken in field work with those taken in lab test, in order to define the value of the shear wave in the solid domain and in the liquid domain.

REFERENCES


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