Available online at www.sciencedirect.com

ScienceDirect

Procedia Earth and Planetary Science 16 (2016) 108 – 117

Procedia Earth and Planetary Science

The Fourth Italian Workshop on Landslides

Influence of the antecedent long-term precipitations on the initial conditions in a sloping pyroclastic deposit

Luca Comegna[a]*, Emilia Damiano[a]

[a]*Second University of Naples, Department of Civil Enigineering, Design, Building and Environment, Via Roma 29, Aversa (CE) 81031, Italy*

Abstract

The hydrological response of a shallow sloping deposit in unsaturated pyroclastic soils is being monitored since 2002. The area is located in Cervinara, Campania Region (Southern Italy), where a catastrophic flowslide occurred on December 16th, 1999, as a consequence of a 2-day cumulative rainfall of 320 mm causing heavy damage and five deaths. The installed devices provide information about rainfall height, soil suction and, recently, also about volumetric water content at several locations and depths along the slope. The huge number and high quality of data allowed to develop a consistent model about the hydrological slope response and particularly to correlate the antecedent long-term precipitations with the soil matric suction at the beginning of a potential triggering rainfall, focusing on the hydrological conditions that establish in the different seasons. In particular, this can help in assessing the likely initial suction values at the time of a potential triggering rainstorm.

Peer-review under responsibility of the organizing committee of IWL 2015

Keywords: Hydrological response; monitoring; unsaturated granular soils; pyroclastic slope

1. Introduction

During the last decades, in Campania (Southern Italy) intense rainfall events triggered flow-like landslides in unsaturated cohesionless pyroclastic sloping covers causing victims and huge economic damages. The return period of such events is about 4 years, as revealed by Table 1 that reports the thirteen main landslides occurred from 1954

* Corresponding author. Tel.: +39-081-5010384; fax: +39-081-5037370.
E-mail address: luca.comegna@unina2.it

Peer-review under responsibility of the organizing committee of IWL 2015
doi:10.1016/j.proeps.2016.10.012

to 2005. In detail: i) eight of them were triggered during Winter; ii) only one event occurred in Spring (the sadly famous Sarno event, May 5th, 1998, that caused 160 victims[1]); iii) four events occurred during Autumn. No relevant landslides were recorded in April, June, July, August and September. This seasonal distribution is not only due to the pluviometric features of the triggering rainstorms (duration, intensity), but also to the unfavourable initial conditions of the covers that are strongly influenced by the previous long-term rainfall history.

Table 1. Main flow-like landslides occurred in Campania Region from 1954 to 2005[2,3].

Site	Month	Day	Year
Gragnano	January	2	1971
Castellammare	January	10	1997
Pimonte	February	17	1963
Mitigliano	February	16	1973
Palma Campania	February	22	1986
Pagani	March	6	1972
Nocera	March	4	2005
Sarno	May	5	1998
Tramonti	October	26	1954
VicoEquense	November	23	1966
Pagani	December	9	1960
Cervinara	December	16	1999
Bracigliano	December	26	2004

The pyroclastic sloping deposits are usually layered. The slope angle is very close to that of the bedrock surface. The thickness of the covers depends on the slope angle, ranging from some decimeters in the uppermost steepest zone (whose inclination is higher than 45°) to more than ten meters at the nearly flat hillfoot[4]. Stability of the steepest areas is assured by soil matric suction, whose regime is strictly related to seasonal climate fluctuation. As a consequence, the probability of slope failure induced by a given storm event changes during the year, being strictly related to the initial soil conditions that are, in turn, determined by the antecedent long-term meteorological variables.

Well aware that field hydrological monitoring is a fundamental tool to better understand the slope response to weather events, since 2002 the research team of the Second University of Naples is being monitoring the seasonal fluctuation of matric suction measured within a shallow sloping deposit in unsaturated pyroclastic soils. The selected area is located in Cervinara, about 50 km North-East of Naples, where on December 16th, 1999, a flowslide was triggered by the most intense 2-day cumulative rainfall recorded in that area (320 mm), killing five people[5]. On November 9th, 2010, a very similar rainstorm (308 mm fallen in two days) was registered in Cervinara but it did not provoke any slope failure. The two opposite effects observed after comparable rainstorms occurred in different periods suggest the key-role of starting conditions on slope response.

After a short description of the monitored site, the paper will report some statistical considerations concerning the field data collected during a 10 years long monitoring period, in order to assess the seasonal influence of antecedent cumulative rainfall on initial conditions.

2. Monitored site

The monitoring station was installed next to the detachment area of the 1999 flowslide. This occurred on a 40° slope, facing North-East at about 560 m a.s.l., located a couple of kilometers upslope the town of Cervinara (Fig. 1a). In the monitored area the pyroclastic cover presents a maximum thickness of about 2.4 m and consists of thin alternating unsaturated layers of pumices and ashes laying upon a fractured calcareous bedrock (Fig. 1b).

The geotechnical properties of such soils have been widely investigated in laboratory[6]. The grain-size distributions of the soils vary from a sandy silt to a sandy gravel. The volcanic materials are characterized by high porosities (55-70%) and quite low values of the soil unit weights (13-16 kN/m^3) due to their nature and their mode of deposition (air-fall). Saturated conductivities range from 9E-07 m/s to 5E-06 m/s but, in unsaturated conditions, they may decrease of more than two order of magnitude. From a mechanical point of view, the soils are characterized by high values of the friction angle (31°-38°) and low to nul values of the effective cohesion. In