How a multidisciplinary work in the Marmara Supersite, related to Earthquake induced landslide hazard, was successful carried out

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Seismic risk is the first source of life and economical losses in Turkey. Located on the North Anatolian fault line, Istanbul and its surrounding areas have been hit by an estimated 120 earthquakes over the last 2,000 years, according to the Istanbul municipality's Disaster Coordination Center.

Besides the seismic threat, landslides in Turkey constitute an important source of loss. The 1999 Earthquake caused extensive landslides while tsunami effects were observed during the post-event surveys in several places along the coasts of the Izmit bay (Altinok et al., 2001).

The seismic landslide hazards have received considerable attention in recent years, but quantitative knowledge on seismic landslide phenomena is still fragmentary, databases with high quality observational data are lacking, and those collateral seismic geohazards are clearly challenging both the scientific community and prevention authorities. These phenomena call for further collaborative researches aiming eventually to enhance preparedness and crisis management.

As one of the three Supersite concept FP7 (EU's Seventh Framework Programme for Research) projects dealing with long term high level monitoring of major natural hazards at the European level, the MARsite project (Nov 2012-Nov 2015) assemble research groups in a comprehensive monitoring activity developed in the Sea of Marmara Region, one of the most densely populated parts of Europe and rated at high seismic risk level since the 1999 Izmit and Duzce devastating earthquakes. Supersites is an initiative of the geohazard scientific community. The Supersites provide access to space borne and in-situ geophysical data of selected sites prone to earthquake, volcano or other hazards.

The 6th Work Package of MARsite project gathers 9 research groups to study earthquake-induced landslides focusing on two sub-regional areas of high interest. First, the Cekmece-Avcilar peninsula, located westwards of Istanbul, is a highly urbanized concentrated landslide prone area (Duman et al., 2006), showing high susceptibility to both rainfalls while affected by very significant seismic site effects (Ergin et al., 2004; Picozzi et al., 2009). Second, the off-shore entrance of the Izmit Gulf, close to the termination of the surface rupture of the 1999 earthquake, that shows an important slump mass facing the Istanbul coastline.

A multidisciplinary research program based on pre-existing studies has been designed with objectives and tasks linked to constrain and tackle progressively some challenging issues related to data integration, modeling, and monitoring.

For the on-shore area, this program included the refined analysis of the seismic site response, the installation of a permanent multi-parameter ground monitoring of a representative unstable slope as well as the in-depth slope stability analysis based on the stress-strain dynamic numerical modelling approach.

After refining the landslide inventory of the peninsula, one landslide (Beylikdüzü landslide) was chosen as pilot site as it resulted the most dangerous due to the highest susceptibility to seismically-induced re-activation and to the highest exposition of buildings and infrastructures referred to the last decade (i.e. after the 1999 Izmit earthquake occurrence). In this landslide area were carried out geophysical campaigns and a field permanent multi-parameter observatory was set up, composed of GPS-RTK, borehole- and surface-seismometers thermometer, rain-gauge, moisture, etc.. Hyperspectral and Dinsar imagery technologies are also deployed to complete inventory and observational information.

Concerning, the modelling of the seismic response and displacements of the pilot landslide, the first step was to have an adequate engineering-geological model. A first engineering-geological model was reconstructed on the basis of extensive geological and geomorphological field campaign and a vast drilling program undertaken by the Istanbul Metropolitan Area. Based on a detailed engineering-geological model of the landslide slope, a not-conventional pseudostatic slope stability analysis (Figure 1) was performed by considering a pseudostatic force distribution within the landslide mass according to a specific wave form instead of a conventional constant pseudostatic force. Numerical simulations of the seismic response in the landslide slope were also performed aiming at evaluating the role of geological and structural setting of the slope on the landslide displacements in case of expected earthquakes.

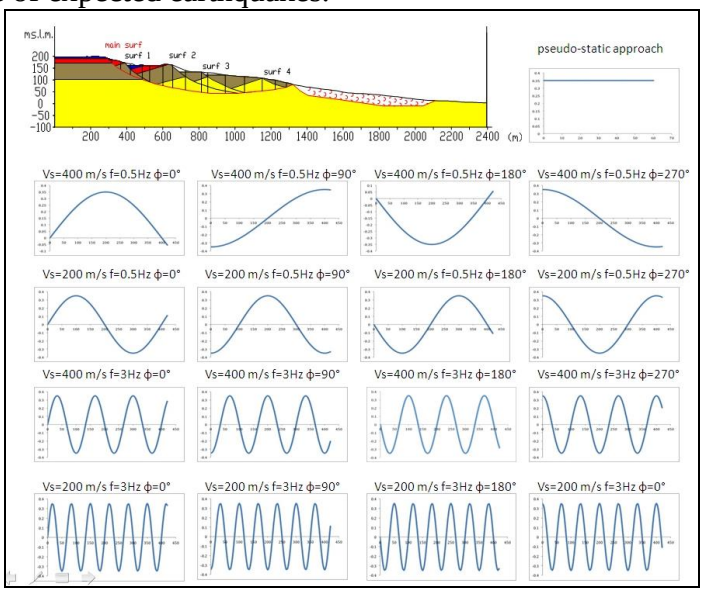

Fig.1 – Conceptual sketch of the here performed not-conventional pseudostatic slope stability analysis.

Multi-parameter monitoring with its long-term time series will be an important tool to validate numerical models and simulations and set up an experimental early warning system for earthquake and rainfall induced landslide.

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