The Effects of Differing Sequences of Earthquake Ground-Shaking on Coseismic Slope Stability

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Introduction

Studies of earthquake-induced landsliding typically consider slope stability during high-magnitude ground shaking events only. During such events, downslope movement of the landslide mass occurs when seismic ground accelerations are sufficient to overcome shear resistance at the landslide shear surface. This approach does not consider the potential effects that sequences of low-magnitude ground shaking events can have on material strength and, hence, coseismic slope stability. Since such events are more common in nature relative to high-magnitude shaking events, it is important to constrain their geomorphic effectiveness. Hence, the aim of this research has been to assess the influence of differing sequences of earthquake ground-shaking events of varying magnitude on the evolution of shear strength and, hence, landslide stability.

Figure 2. Collection of undisturbed blocks of sediment from the Hollister Hills State Vehicular Recreation Area, California, USA. A and B display the sampling locations within the slope. C, D and E display the gradual isolation and removal of the undisturbed blocks.

Scope and funding

I undertook a laboratory study using a bespoke geotechnical testing apparatus, the Dynamic Back-Pressured Shear Box (DynBPS) that permits realistic simulation of earthquake ground-shaking conditions within a hillslope. **Funding from the British Society for Geomorphology** allowed me to undertake fieldwork in the Hollister Hills State Vehicular Recreation Area and at the Weeks Creek Landslide, California, USA in December 2013 to collect undisturbed sediment samples (Fig. 1) from locations that have previously been subjected to differing sequences of earthquake ground shaking. These samples were transported back to Durham University and used in an extensive experimental laboratory testing programme.

Summary of results

I found that multiple dynamic stress/shaking events that are largely insufficient to cause large strains can affect material stiffness such that the future behaviour of the sediment/landslide differs considerably from that observed in standard shear tests. The sequence of ground-shaking events is an important control; where shaking conditions cause progressive densification of sediment, the frictional strength of the material subsequently increases. In turn, the resultant strain response to high-magnitude ground shaking events decreases.

Research outputs

The preliminary findings of this research have been presented at two key conferences:

1. EGU General Assembly, Vienna, Austria. April 2015
2. AGU Fall Meeting, San Francisco, USA. December 2015.

The results will shortly (July 2016) be submitted for publication, and will be used as the basis for further grant support. **BSG funding has been critical to the progress of this research and this funding is gratefully acknowledged.**