A Simulation Study of Loess Slope Instability and Damage Under Intensive Seismic Vibration

chaoyu chang (✉ changchaoyu@126.com)

China Earthquake Administration Institute of Engineering Mechanics <https://orcid.org/0000-0002-1365-4471>

Jingshan Bo

Institute of Disaster Prevention

WenHao Qi

China Earthquake Administration Institute of Engineering Mechanics

feng qiao

Institute of Disaster Prevention

da peng

China Earthquake Administration Institute of Engineering Mechanics

Research Article

Keywords: Loess slope landslide under seismic vibration, Particle flow discrete element, instability damage, PFC2D

Posted Date: April 28th, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-291634/v1>

License: © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Abstract

The instability and damage of the loess slope under intensive seismic vibration can be a complicated process, involving in sliding, horizontal displacement and rotation, which makes the particle flow code a suitable theory to simulate the instability and damage of the loess slope. In this study, based on both field investigation and indoor experiments, PFC2D program was adopted to simulate the instability and damage process of the loess slope landslide under intensive seismic vibration through the detailed identification of relevant parameters, model building and dynamic input. The analysis has revealed three main findings. Firstly, the valley surface structure dominated in the slope tends to magnify the vibration, resulting in intensive vibration of the soil body on the slide surface and an increased high frequency components of Fourier spectrum. Secondly, under the dynamic forces, the slope first accumulates and damages in the lower part, forming a shear outlet. Under the pulling of the lower particles, the difference between the first principal stress and the third principal stress gradually increases, destroying the inherent cohesive contact between the particles, leading to the instability damage. Thirdly, the upper soil body experiences tensile damage, forming a through slide face which causes the instability damage of the whole slope. The sliding face demonstrates in a oval shape, with a deeper arch as the vibration lasts longer.

Full-text

Due to technical limitations, full-text HTML conversion of this manuscript could not be completed. However, the manuscript can be downloaded and accessed as a PDF.

Figures

Figure 1

The loess earthquake landslides induced by 95 Haiyuan earthquake in 1920

Figure 2

The survey setup in Subao Village landslide Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.

Figure 3

The stratum of Subao Village landslide based on the survey

Figure 4

The overview of Subao Village landslide

Figure 5

The Stratigraphic profile of Subao Village landslide

Figure 6

The illustration of calculation cycle

Figure 7

The direct shear test model for the identification of mesomechanical parameters

Figure 8

The shear force and displacement curve in the direct shear simulation tests

Figure 9

The simulated direct shear test strength curve

Figure 10

The strata profile after the landscape restoration

Figure 11

The slope model in PFC

Figure 12

Seismic wave input

Figure 13

The measure circle and locations

Figure 14

Acceleration time history at various measurement points

Figure 15

Speed time history at various measurement points

Figure 16

Displacement time history at various measurement points

Figure 17

Fourier spectrums at various measurement points

Figure 18

Magnification coefficient of acceleration peak 277 at various measurement points

Figure 19

The displacement cloud diagram of slope at various moments

Figure 20

The stress time history of primary stresses within various measurement circles

Figure 21

The shear stress time history curve within 323 various measurement circles