Abstract

Strong earthquake often associated with large landslides and induced catastrophic hazards. The common types of slope failure are plane, wedge, trellis, and complex failures. In this study, the Tsaoling landslide and Daguangbao landslide which induced by the 1999 Chi-Chi earthquake and the 2008 Wenchuan earthquake with plane and wedge failure are taken for comparison in order to understand the differences between the two types of landslide. According to previous research, the seismic accelerations are often used to analyse Tsaojing and Daguangbao landslides from the seismic strains CHY080 and MZQP respectively. The seismic strains CHY080 on the mountain side for a duration of 500m in the northeast of Tsaojing landslide, the seismic topographic effects enhances seismic acceleration, the seismic acceleration with frequency of 0.5–5 Hz. The MZQP is on the footwall of Yingxian–Chuanxian fault the Daguangbao landslide is on the hanging wall, the frequency of the seismic acceleration is 1.5–5 Hz, higher than CHY080. The frequency of seismic acceleration, sliding direction; friction law of sliding plane of Tsaoling landslide are different from Daguangbao landslide. The method which provided in previous studies for plane failure and Wedge Method (WM) and Maximum Shear Stress Method (MSSM) for wedge failure are applied to calculate the stability of the sliding block. The friction law, the horizontal seismic acceleration perpendicular to the intersection line of weak planes, the angle between the two weak planes are changed to analyse the parametric sensitivity. The result shows that the angle between the two weak planes increase, the stability of the sliding block is higher. The plane failure can be regarded as the extreme condition of wedge failure with the angle between two weak planes at 180°. The wedge failure is more stable than plane failure. In the previous study, the friction coefficient of the sliding plane decreases with the velocity and displacements increases. This slip-weakening phenomena can be described by a friction law. We can establish the friction law of the weak plane material with the rotary shear test. The Newmark analysis incorporates the friction law as the force of the sliding block, the integration of the acceleration given velocity and displacements and wedge failure by seismic acceleration. Preliminary results show that the Daguangbao landslide only slip for 0.04m and 0.05m with 0.12m and 0.15m by Newmark displacement method. To investigate why the results of Newmark displacement method of Daguangbao landslide is not corresponding to the fact, we assume the block of Tsaojing landslide in wedge block and calculate the displacements by Newmark displacement method. The Block slides for high velocity and long-range displacements with the conditions of seismic acceleration and earth pressure. The wedge failure is more stable and prone of Daguangbao landslide. Therefore, the frequency of seismic acceleration probably affect the results of the analysis of Newmark displacement method.

Key Words: Earthquake-triggered landslide, plane and wedge failure, rigid wedge method and maximum shear stress method, friction law, Newmark displacement method.

Methodology

**Plane failure**

- Seismic strain: CHY080, MZQP
- Frequency: 0.1–5 Hz
- Maximum amplitude: 1.2 Hz

**Wedge failure**

- Seismic strain: CHY080, MZQP
- Frequency: 1.5–5 Hz
- Maximum amplitude: 3.2 Hz

Friction law

- Bedding parallel fault: $\mu_s = 0.36$, $\mu_c = 0.12$

Results and Discussion

**Newmark displacement method**

- Wedge failure: building parallel fault
- Rigid wedge method
- Maximum shear stress method

**Daguangbao landslide**

- Angle between weak planes: $32°$, $56°$

**Tsaojing landslide**

- Angle between weak planes: $18°$, $32°$

Conclusions

1. The Newmark analysis of Daguangbao landslide is a high-speed sliding with the same acceleration of Tsaojing case. The frequency of seismic acceleration of Daguangbao landslide is with high frequency about 1.5–15 Hz, Tsaojing landslide is 0.3–3 Hz. The frequency of seismic acceleration may be the most important factor for Daguangbao landslide to slide for short distance Newmark analysis.

2. As the angle between the two weak planes from gentle to steep, the block is more likely to slide. The wedge failure is more stable than plane failure.

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