STATISTICAL ANALYSIS OF LANDSLIDES TRIGGERED BY WENCHUAN EARTHQUAKE

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1. Introduction

At 14:28 on May 12, 2008, M_s 8.0 earthquake occurred in Wenchuan prefecture of Sichuan Province. Wenchuan earthquake was triggered by the movement of Longmen Mt. fault, which is a thrust fault and along the border of eastern Tibetan Plateau and the Yangtze plate (Sichuan Basin). It includes three main faults, as shown in **Fig.1**. The length of Longmen Mt. fault is about 500km, width is 40 ~ 50km, the overall strike is N40°~ 50°E¹. Landslides occurred in Wenchuan prefecture were surveyed along National Road 213, The investigation route is shown as **Fig.2**. This paper studied landslide distribution regularity and gave some recommendations.



Fig.1 Longmen Mt. topography and faults

2. Landslides Related to Slope Strike

Strikes of 106 landslides were measured and they were classified into eight groups according to strike direction, such as E (-22.5~22.5°), NE45° (22.5~67.5°), NW45° (112.5~157.5°), W (157.5~202.5°), SW45° (202.5~247.5°), S (247.5~292.5°), SE45° (292.5~337.5°). The number of landslides in each group was marked on the direction coordination system, shown as **Fig.3**, it suggests the total number of landslides with strike N45°E (equal to NE45° and SW45°) is much more than those in other directions. The number of landslides decreases with the increment of the angle between slope strike and fault strike, when perpendicular to the strike of the earthquake source fault, the number of landslides becomes fewest. That is to say, when other influential factors to slope stability are constant, if the slope with parallel strike to the fault, it was more vulnerable to failure. Other interesting



Fig.2 Investigation route



distribution and slope strike

phenomenon is that the number of landslides in group NE45° is obviously more than others. Because the earthquake rupture spreaded from epicenter to the northeast direction along the source fault, which strike is N40~50°E, it can be inferred that landslides distribution regularity is related with rupture spreading direction and there are more landslides along the rupture spreading direction, this phenomenon can be named as earthquake rupture spreading effect.

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3. Hanging-foot wall effect

There are two faults going through Wenchuan prefecture and Wenchuan earthquake occurred at Yingxiu-Beichuan fault. This fault is a thrust fault, north-western zone from Yingxiu-Beichuan fault is hanging wall side and the south-eastern zone is footwall side, as shown in **Fig.2**. Landslide area distribution ratio were calculated and compared within two comparable zones. The results are shown in **Fig.4**, based on ranks of sliding volume. It shows landslide area distribution ratio of small landslide on the footwall side is almost the same as that on hanging wall side between two faults, while landslide area distribution ratios of medium and large landslide on the hanging wall side between two faults are 3.1 and 3.7 times larger than those on the footwall side, respectively. The average landslide area distribution ratio of hanging wall side between two faults is 2.5 times as large as that of footwall. This phenomenon is named as hanging-foot wall effect.





Fig.4 Landslide area distribution ratios of hanging wall and footwall



On account of hanging-foot wall effect, 115 seismic stations were assorted into two groups according to their locations. The authors developed regression formulae for estimating horizontal peak ground acceleration within the hanging wall and footwall, respectively. The formulae are as follows:

Hanging wall:
$$\log_{10} PGA = 4.92 - 1.36 \log_{10} (D_{rup} + 23.7)$$
 (1)

Foot wall:
$$\log_{10} PGA = 4.42 - 1.27 \log_{10} (D_{rup} + 17.5)$$
 (2)

Where PGA denotes horizontal peak ground acceleration (gal); D_{rup} represents nearest horizontal distance from interested site to the surface fault rupture of USGS model (km)²⁾. The two regression curves are shown in **Fig.5**, which reveals that horizontal peak ground acceleration of hanging wall is apparently larger than that of footwall. According to these regression results, it is concluded that hanging-foot wall effect was induced by the earthquake acceleration difference between hanging wall and footwall.

4. Conclusions

Wenchuan Earthquake caused huge casualties and economic losses, This paper focused on the landslides in Wenchuan prefecture and analyzed the distribution regularity of landslides, conclusions are as follows: (1) The slope with parallel strike to the fault is more vulnerable to failure and there are more landslides along the rupture spreading direction, If the transportation infrastructure are unavoidable to be established in the zone of thrust fault and intersects with fault, it's recommend that infrastructure vertically go across the fault; (2) Horizontal peak ground acceleration of hanging wall is distinctly larger than that of footwall; therefore, the authors recommend hanging-foot wall effect had better be considered when the project is nearby the thrust fault.

5. References

1) Yang Q.H.: Research on Landslide Dynamical Characteristics of Sand Model and Slope under Strong Disturbance. Doctor thesis, Southwest Jiatong Unveristy, Chengdu, China, 2010.pp.23-25.

2) Chen Ji, Gavin Hayes: Finite fault model-preliminary result of the May 12, 2008 M_w 7.9 eastern Sichuan, China earthquake. The web of national earthquake information center (NEIC) of United States geological survey, 2008.