

## **Disaster Characteristics and Mitigation Measures of Huge Glacial Debris Flows along the Sichuan-Tibet Railway**

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The Ranwu-Tongmai section of the Sichuan-Tibet Railway passes through the Palongzangbu River basin which locates in the southeast Qinghai-Tibetan Plateau. Due to widely distributed maritime glacier in this area, the huge glacier debris flows are very developed. Consequently, the disastrous glacier debris flows with huge scale ( $10^6$ - $10^8$  m<sup>3</sup> for one debris flow event) and damage become one of the key influencing factors for the route alignment of the Sichuan-Tibet Railway.

The research on disaster characteristics and mitigation measures of huge glacial debris flows in the study area were conducted by the remote sensing interpretation, field investigation, parameter calculation and numerical simulation. Firstly, the distribution of the glaciers, glacier lakes and glacier debris flows were identified and classified; and the disaster characteristics for the huge glacier debris flow were analyzed and summarized. Secondly, the dynamic parameters including the flood peak discharge, debris flow peak discharge, velocity, total volume of a single debris flow event were calculated. Based on the disaster characteristics and the spatial relation with the railway, some mitigation principles and measures were proposed. Finally, the Guxiang Gully, where a huge glacier debris flow with  $2 \times 10^8$  m<sup>3</sup> in volume occurred in 1953, was selected as a typical case to analyze its disaster characteristics and mitigation measures.

The interpretation results show that the glacier area is about 970 km<sup>2</sup> which accounts for 19% of the total study area. 130 glacier lakes and 102 glacier debris flows were identified and classified. The Sichuan-Tibet Railway passes through 43 glacier debris flows in the study area. The specific disaster characteristics were analyzed and corresponding mitigation measures were proposed for the route selection of the railway. For the Guxiang Gully, a numerical simulation to simulate the deposition condition at the alluvial fan was conducted. the simulation results show that the accumulation length is 1.91 km and 1.75 km, and the accumulation width is 4.71 km and 3.68 km for the case of P=0.5% and P=1% respectively. The accumulation depth along the main flow direction is 40~60m and 25~35m. Consequently, four plans of railway alignment including passing through the down-stream by tunnel, passing through the gully outlet by tunnel and bridge, passing through the middle-lower part of the accumulation fan by railway bed and bridge, passing through the middle-lower part of the accumulation fan by tunnel were presented. The four plans were compared and related debris flow mitigation measures were provided.