Postprint: Disintegration and Fragmentation Effects of High-Elevation Rock Landslide Debris Flows Based on Large-Scale Physical Model Experiments

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Abstract

Disintegration and fragmentation effects are ubiquitous during the motion of high-position rockslides, capable of transforming both the material state and kinematic state of the landslide mass, thereby influencing its energy distribution and dynamic transmission characteristics. To investigate the disintegration and fragmentation characteristics and energy dissipation patterns of high-position rockslide debris flows, and to reveal their dynamic transmission mechanisms, large-scale physical model tests were conducted, focusing on the influences of source zone block strength, volume, thickness, degree of joint development, and slope gradient on rock mass disintegration and fragmentation. The results indicate that during the dynamic transmission process of high-position rockslide debris flows, the front portion experiences significantly less velocity loss than the rear portion, the leading edge exhibits a distinct "secondary acceleration," and substantial fine particles accumulate at the distal end. The landslide mass demonstrates a pronounced velocity and dynamic transmission effect from the rear to the front, with this effect becoming more significant as the degree of fragmentation increases. The disintegration and fragmentation process is accompanied by energy transformation, transmission, and loss; controlled by the degree of fragmentation, the energy consumed by fragmentation accounts for approximately 3.32%~21.03% of the total potential energy.

Full Text

Preamble

Title: Disintegration and Fragmentation Effect of High-Position Rock Landslide Debris Flow Based on Large-Scale Physical Model Test

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Abstract:

Disintegration and fragmentation effects are ubiquitous during the motion of high-position rock landslide debris flows, fundamentally altering material composition and kinematic behavior while influencing energy distribution and dynamic transfer characteristics. To investigate the fragmentation features, energy dissipation patterns, and dynamic transfer mechanisms of these flows, we conducted large-scale physical model tests focusing on source-zone parameters including block strength, volume, thickness, joint development degree, and slope gradient. Our results demonstrate that during dynamic transfer, the frontal region experiences substantially less velocity attenuation than the rear portion, with the leading edge exhibiting distinct "secondary acceleration" and fine particles accumulating at distal locations. A pronounced velocity and dynamic transfer effect occurs from the rear to the front of the landslide mass, intensifying with increasing fragmentation degree. The disintegration process involves continuous energy transformation, transmission, and dissipation, with fragmentation energy consumption accounting for approximately 3.32% to 21.03% of the total potential energy, depending on fragmentation intensity.

Keywords: high-position rock landslide debris flow; large-scale physical model test; dynamic transfer; disintegration and fragmentation; energy dissipation; engineering

Note: Figure translations are in progress. See original paper for figures.