Damage Process of In-Service Check Dams Under Typical Debris Flows in Southwestern Mountainous Areas: Postprint

Authors: Luo Chaopeng, Kang Yongchuang

Date: 2025-09-02T14:54:22+00:00

Abstract

The mountainous regions of southwestern China are characterized by steep terrain, deeply incised valleys, and complex geological structures. Debris flows, as the predominant geological hazard type in this region, severely constrain regional economic development due to their typical characteristics of beyond-frequency outbreak, ultra-high dynamic damage, and complex dynamic movement processes. This study utilizes the OpenLISEM numerical simulation platform, incorporating rainfall, topographic, and material source parameters from Chutou Gully and Sucun Gully in Wenchuan County, to conduct numerical simulations of the complete debris flow process encompassing initiation, movement, and deposition. Through back-analysis of the August 20 debris flow event in Chutou Gully and the July 10 event in Sucun Gully, key parameters including flow velocity, flow depth, and deposition range were obtained. Model configurations and related parameters were dynamically calibrated based on actual data, achieving simulation accuracy index Ω values of 1.57 and 1.37, respectively, which indicate substantial agreement between simulation results and observed data. Furthermore, this research predicts the dynamic damage processes of potential debris flow outbreaks under check dam service conditions at rainfall frequencies of 5%, 2%, and 1% for both gullies, providing reasonable recommendations for subsequent disaster prevention and mitigation efforts. This paper reveals the dynamic evolution laws and complete movement processes of debris flows in southwestern mountainous regions under check dam constraints, with the research content and methodology offering data support and theoretical references for predictive studies of analogous debris flows in the region.

Full Text

Preamble

Title: Study on the Typical Debris Flow Damage Process under Check Dam Service in Southwest Mountainous Areas

Authors: Luo Chaopeng, Kang Yongchuang

Affiliation: Guiyang Survey Design and Research Institute of Chinese Electric Power Construction Group Co., Ltd., Guiyang 550081

Abstract

The southwestern mountainous region of China is characterized by steep terrain, deeply incised valleys, and complex geological structures. Debris flows represent the primary geological hazard in this area, exhibiting typical features of exceeding-frequency outbreaks, ultra-high dynamic damage potential, and complex dynamic movement processes that severely constrain regional economic development. This study employs the OpenLISEM numerical simulation platform, integrating rainfall, terrain, and material source parameters from Chutou Gully and Sucun Gully in Wenchuan County. Through comprehensive numerical simulation of the entire debris flow process—including initiation, movement, and deposition—we back-analyzed the August 20 debris flow event in Chutou Gully and the July 10 event in Sucun Gully. Key parameters such as flow velocity, flow depth, and deposition extent were obtained, and model settings and related parameters were dynamically calibrated using actual observation data. The resulting simulation accuracy metric Ω values reached 1.57 and 1.37 respectively, indicating substantial agreement between simulation results and field observations.

Furthermore, we predicted the dynamic damage processes of debris flows in Chutou Gully and Sucun Gully under check dam service conditions during rainfall events with 5%, 2%, and 1% frequencies, providing reasonable recommendations for future disaster prevention and mitigation efforts. This research reveals the dynamic evolution laws and complete movement processes of debris flows in southwestern mountainous areas under check dam constraints. The research content and related methodologies can provide data support and theoretical references for predictive studies of similar debris flows in the region.

Keywords: debris flow; check dam; OpenLISEM; numerical simulation; dynamic damage

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