Estimation method of debris flow load using a channel flume with a movable bed using distinct element method
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In Japan, the frequency of debris flow disasters has been increasing each year, with large-scale events often triggered by localized torrential rainfall and typhoons. Generally, debris flows can be classified into two categories: boulder type and mudflow type. Among these, bouldery debris flow characterized by the concentration of large boulders at the front part, impart extremely high impact forces and can cause severe damage to residential areas and other communities. Consequently, the development and implementation of effective countermeasures against these hazards has become an urgent priority. Among the various mitigation measures, steel pipe open Sabo dams (referred to as open Sabo dams) have been constructed. In current design practice, the hydrodynamic forces of debris flows acting on the upstream side of the dam are combined with sediment pressure loads extending from the downstream side toward the upstream side. However, recent cases of damage to steel dam members and failures at joint sections have been reported. An analysis of these damaged structures revealed that the loads acting on the dams can vary locally, influenced by the riverbed morphology and the sediment already captured. These findings underscore the need for a more detailed analysis of debris flow loads. Consequently, it is necessary to investigate and clarify the mechanisms underlying load evaluations under conditions resembling a mobile bed, where gravel is present from the outset. The study conducted load experiments under movable bed conditions, focusing on the temporal evolution of the load to clarify its characteristics. Furthermore, using the distinct element method (DEM), it performed numerical simulations to reproduce debris flow loads under conditions where a mobile bed and pre-accumulated gravel were present. The results revealed that pre-accumulated gravel significantly influences the maximum load acting on the entire dam. Large loads occur where the debris flow front collides with each step level of the dam. In addition, by examining contact force distributions and velocity vector diagrams during the transition from flow to collision, the results investigated the underlying mechanisms of impact forces in debris flow loading.