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Kinematics and mechanics of 1999 Tsaoling landslide revealed by 3-D discrete element modeling

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At least five large landslides occurred in Tsaoling area are induced by big earthquake and heavy rainfalls since 1862 to 1999. The recent catastrophic Tsaloing landslide was triggered by 1999 Chi-Chi earthquake triggered, which mobilized about 0.125 cubic kilometer of rock and soil that slid across the Chingshui River and created a 5 km long natural dam. One fifth of the landslide mass dropped into the Chingshui River, the rest jumped over the river. Geological investigation shows that the prevailing attitude of sedimentary formation is about N45W with a dipping angle of 12S. The landslide mechanism may be including flowing, rolling, bouncing and sliding, thus we use 3D discrete element method (PFC3d code) to characterize kinematic process and mechanics of Tsaoling landslide. Our numerical model was compose of about 30,000 spherical elastic particles with radius of 5.61-9.95 meters that were bonded together to create an pre-slid rock mass on the 13,512 triangular facets based on the pre-earthquake topography. The marcoproperties of rock mass was estimated by numerical triaxial test and the friction coefficients of 0.01, 0.03, 0.05 and 0.1 on slip surfaces are used to compare the topography of landslide area and runout path. Three sorts of bond strength (Parallel bond) were adopted to represent different rock strength, and to compare the accumulation sequence of masses slipped. The strong, moderate and weak bond strengths are 31.6 MPa, 21 MPa and 10.5 MPa respectively. The investigation of the impact area induced by gigantic landslide event is a crucial topic, thus several numerical scenarios were done to elucidate the mechanics and kinematics of landslide process.