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The kinematics and initiation mechanisms of the earthquake-triggered Daguangbao landslide

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The Daguangbao (DGB) landslide is one of the largest earthquake-triggered landslides induced by the 2008 Wenchuan earthquake in the world over the past century. Based on remote sensing images, topography analysis and field investigation, this landslide was speculated a gigantic atypical wedge failure with the folded bedding plane and a zigzag stepping-out joint system, which outcropped at the south and north, respectively. With the inferred failure surfaces, the volume of the DGB landslide is about 1,051 Mm3. The frequently adopted Rigid Wedge Method (RWM), which assumed zero shear stress on the sliding surface along the vectors perpendicular to the intersection line when evaluating the wedge stability, could not be valid for this super large DGB wedge. Under an assumption that the shear strength is fully mobilized on the sliding surface along the vectors perpendicular to the intersection line, this study proposed to use a Maximum Shear Stress Method (MSSM) to calculate the factor of safety (FOS) of the DGB wedge. Based on the assumptions of the two methods, the FOS of the RWM and MSSM are the upper and lower bounds for the wedge stability analysis. Based on the rotary shear tests, the averaged friction coefficients of the representative materials of the two sliding surfaces are 0.79 (bedding parallel fault gauges) and 0.71 (dolomite joints). Without external force, the FOSs of the DGB landslide are 4.14 and 2.51 by the RWM and MSSM, respectively. Restate, the wedge is stable before the 2008 Wenchuan earthquake. However, DGB landslide can be triggered at 35.7 sec based on the ground acceleration records of strong motion station MZQP during the 2008 Wenchuan earthquake and the pseudo-static stability analysis incorporated into MSSM (Acceleration: EW=0.272g, NS=0.152g, Vertical=0.244g). Moreover, using the friction coefficient of the representative materials under large shear displacement under shear velocity of 1.3 m/s (0.16 for bedding parallel fault gouges and 0.1 for dolomite joints), the gigantic wedge can be speeded up to a maximum velocity of 54 m/sec. The traveled time will be 70 seconds with a travel distance of 1.9 km.