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Dynamic growth of slip surfaces in catastrophic landslides. (English) Zbl 1371.86002
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Summary: This work considers a landslide caused by the shear band that emerges along the potential slip (rupture) surface. The material above the band slides downwards, causing the band to grow along the slope. This growth may first be stable (progressive), but eventually becomes dynamic (catastrophic). The landslide body acquires a finite velocity before it separates from the substrata. The corresponding initial-boundary value problem for a dynamic shear band is formulated within the framework of *A. C. Palmer* and *J. R. Rice*'s [Proc. R. Soc. Lond., Ser. A 332, 527–548 (1973; Zbl 0273.73059)] approach, which is generalized to the dynamic case. We obtain the exact, closed-form solution for the band velocity and slip rate. This solution assesses when the slope fails owing to a limiting condition near the propagating tip of the shear band. Our results are applicable to both submarine and subaerial landslides of this type. It appears that neglecting dynamic (inertia) effects can lead to a significant underestimation of the slide size, and that the volumes of catastrophic slides can exceed the volumes of progressive slides by nearly a factor of 2. As examples, we consider the Gaviota and Humboldt slides offshore of California, and discuss landslides in normally consolidated sediments and sensitive clays. In particular, it is conceivable that Humboldt slide is unfinished and may still displace a large volume of sediments, which could generate a considerable tsunami. We show that in the case of submarine slides, the effect of water resistance on the shear band dynamics may frequently be limited during the slope failure stage. For a varying slope angle, we formulate a condition of slide cessation.

MSC:

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74L10 Soil and rock mechanics
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