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Acoustic emissions (AE) during failure of granular media

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The release of shallow landslides and other geological mass movements is the result of progressive failure accumulation. Mechanical failure in disordered geologic materials occurs in intermittent breakage episodes marking the disintegration or rearrangement of load-bearing elements. Abrupt strain energy release in such breakage episodes is associated with generation of elastic waves measurable as high-frequency (kHz range) acoustic emissions (AE). The close association of AE with progressive failure events hold a promise for using such noninvasive methods to assess the mechanical state of granular Earth materials or for the development early warning methods for shallow landslides. We present numerical simulations that incorporate damage accumulation and associated stress redistribution using a fiber-bundle model. The stress released from element failure (fibers) is redistributed to the surrounding elements and eventually triggers larger failure avalanches. AE signals generated from such events and eventually hitting a virtual sensor are modeled using visco-elastic wave propagation laws. The model captures the characteristic saw-tooth shape of the observed stress-strain curves obtained from strain-controlled experiments with glass beads, including large intermittent stress release events that stem from cascading failure avalanches. The model also reproduces characteristics of AE signatures and yield a good agreement between simulation results and experimental data. Linking mechanical and AE information in the proposed modeling framework offer a solid basis for interpretation of measured field data.