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Velocity Regimes for Sphere Penetration of Granular Materials[1]
MEHDI OMIDVAR, STEPHAN BLESS, New York University Polytechnic Institute, IVAN GUZMAN, New York UniversitNew York University Polytechnic Institute, MAGUED ISKANDER, New York University Polytechnic Institute — Penetration of granular materials as a function of velocity is made complex by transitions where one or another physical process is dominant. At the lowest velocity, bearing resistance (which depends on friction and depth) is dominant, then dynamic Coulomb friction, then inertial resistance, then particle crushing. There is also a special regime where resistance is very high during the first radius of penetration, probably due to shock wave effects. These transitions are very evident in penetration of dry sand, between 0 and 300 m/s, as revealed by measurements of deceleration and the final depth of penetration. With crushed quartz particles, the particle crushing regime is not observed. Additionally, in saturated sand, the crushing regime appears to be suppressed. The regime where particles are crushed corresponds to an increase in penetration resistance, and this plays a large role in the relative difficulty in penetration of dry as opposed to wet materials. Measurements of deceleration give rise to estimates of average stress in the granular materials. For the case of sand, the threshold for comminution is at about 100 MPa, and this is also where significant crushing of sand is seen in triaxial compression experiments.

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stephan bless
New York University

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