Use of Controlled Blasting for the Evaluation of the Deep, In Situ Dynamic Response of Soils

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As part of its long-term resilience goals, the Port of Portland has determined that one of its two runways must be hardened against the vertical and lateral deformations anticipated following rupture of the Cascadia Subduction Zone and the nearby, smaller, Port Hills fault. Both runways lie in close proximity to the Columbia River, which has been dredged to maintain shipping channels to depths as great as 20 m. Lateral spreading has been determined to pose a significant risk to the runways, given that the subsurface consists of dredge sand fill, medium stiff silt, and a deep deposit of medium dense sand. Prior to selecting and executing a costly ground improvement program, the Port has determined that an improved understanding of the cyclic resistance of the silt and sand deposits is warranted. Deep, in-situ, blast liquefaction experiments were conducted to provide a means to understand the seismic performance of these soils without the possible effects of sample disturbance, small sample-size effects, artificial drainage conditions, and under existing mechanical and hydrogeological conditions. The findings, which include characterization of blast-induced body waves, relationships between shear strain and excess pore pressure, shear strain and shear modulus degradation, and post-liquefaction volumetric strain, will be used by the Port's consultants to calibrate numerical models and guide the sizing of the planned ground improvement program. The technique developed and deployed in this study can be used to determine fundamental dynamic soil properties in any soil and at any depth.