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Unique Relationship between Small Strain Shear Modulus and Effective Stresses at Failure for Dilatant Soils

Christopher D.P. Baxter, M.S. Ravi Sharma, Yaurel Guadeluppe-Torres

Depts. of Ocean/Civil and Environmental Engineering

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- Professor Drnevich
- Professor Leonards
- My Purdue Family

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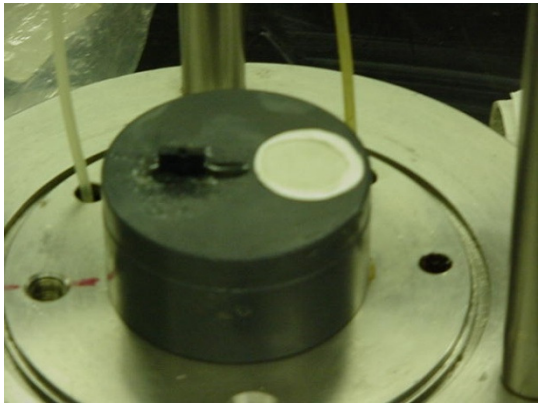
Outline

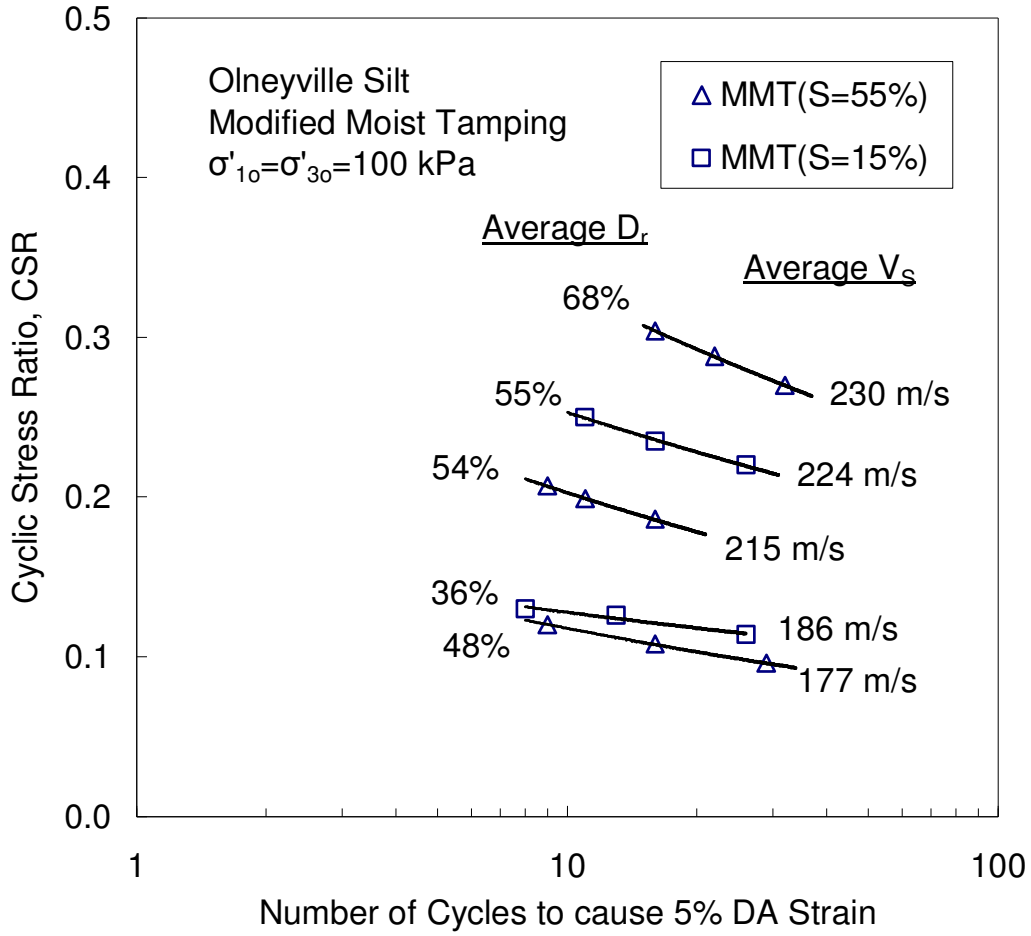
- Introduction
- Shear wave velocity measurements at URI
- Small strain shear modulus of a cemented soil during shear
- Relationship between small strain shear modulus and effective stresses at failure
- Possible Implications
- Conclusions

Shear Wave Velocity Measurements at URI

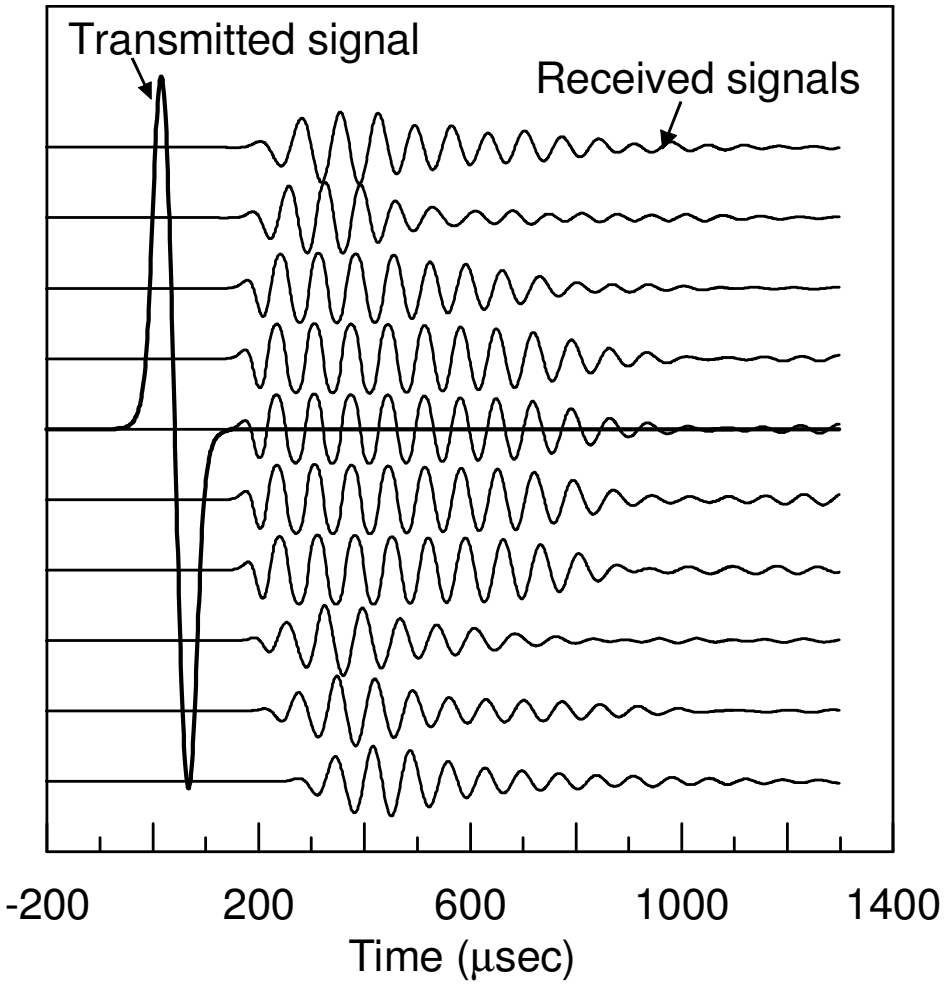


Bender Elements

Torsional Shear Transducers

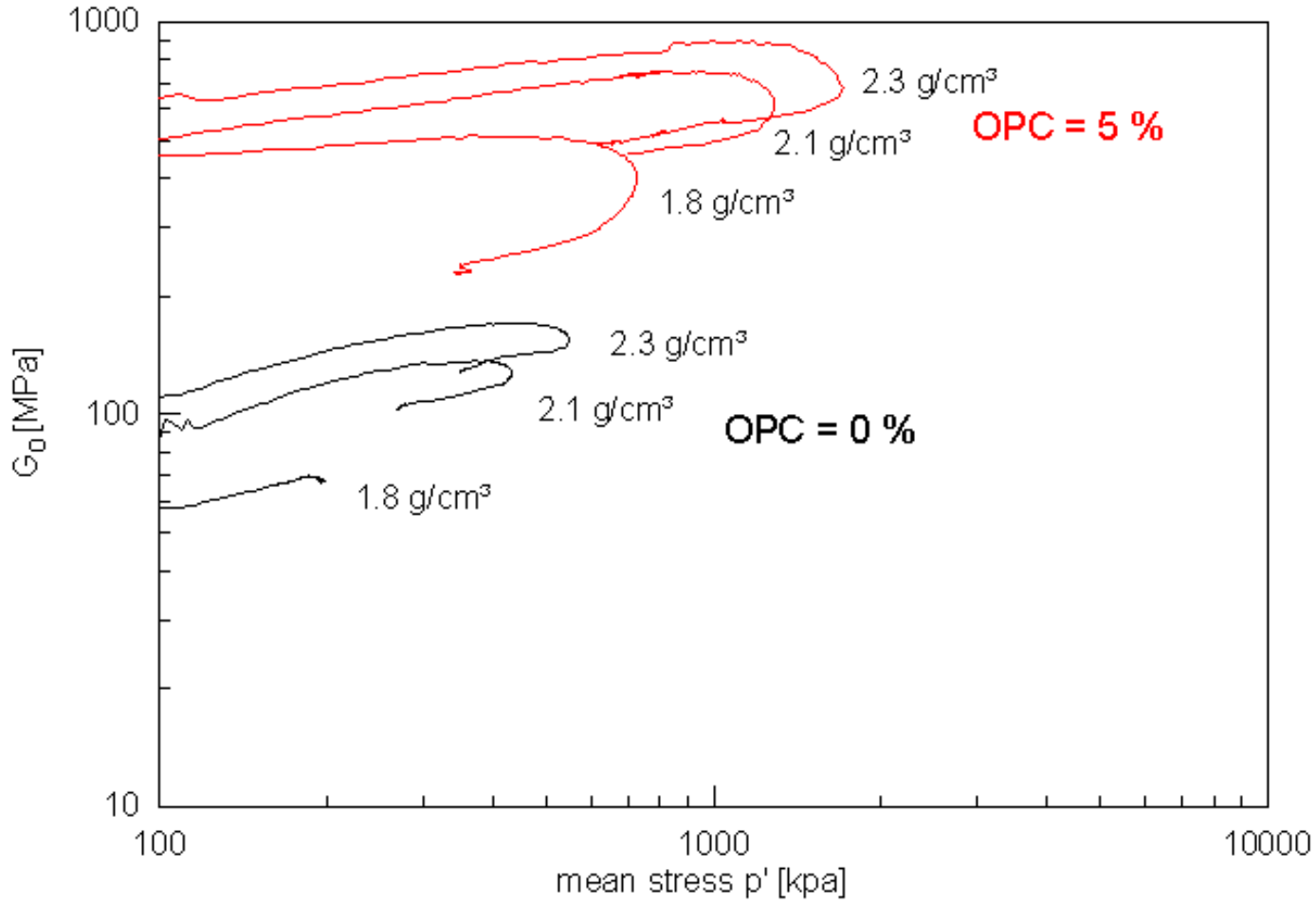


Shear Wave Velocity Measurements During Shear

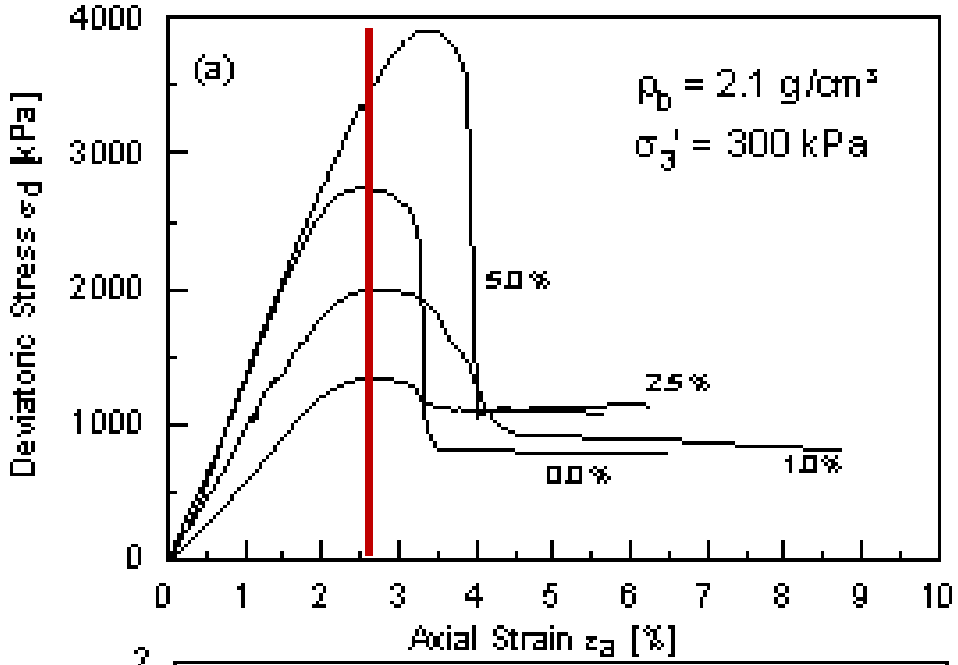


- As part of a study on weakly cemented sands funded by BP America, Inc., 22 drained triaxial tests were performed on samples of varying densities and degrees of cementation
- Shear wave velocity was measured continuously during shear using torsional shear transducers

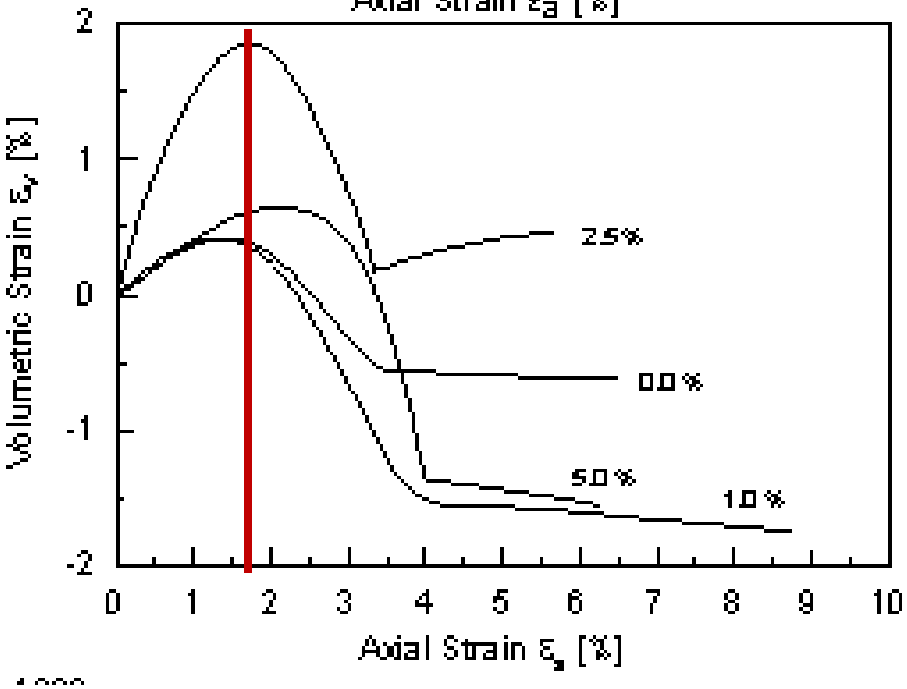
Effect of Density and Cementation on Small Strain Shear Modulus During Shear

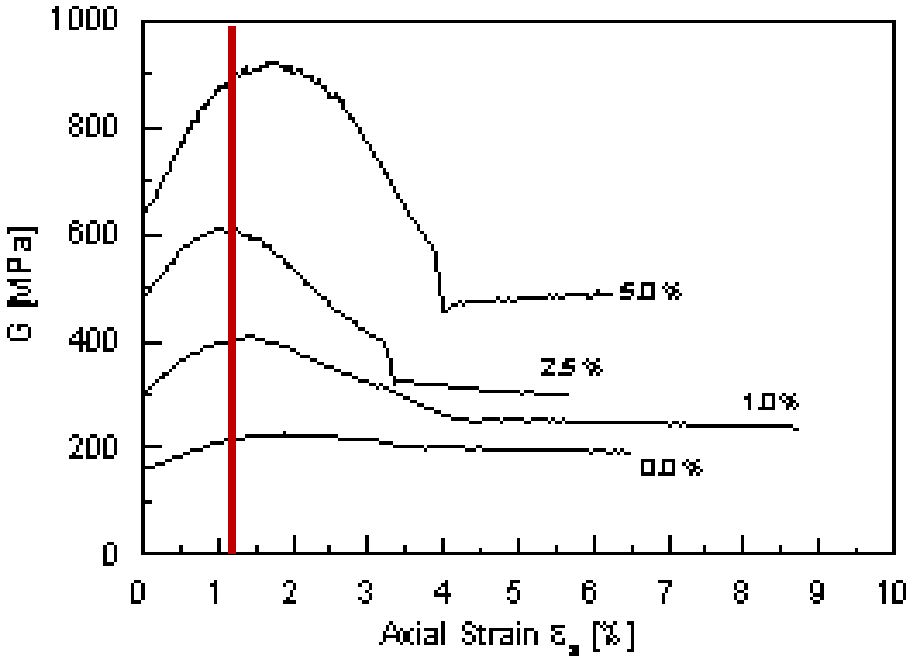


OPC = Ordinary Portland Cement

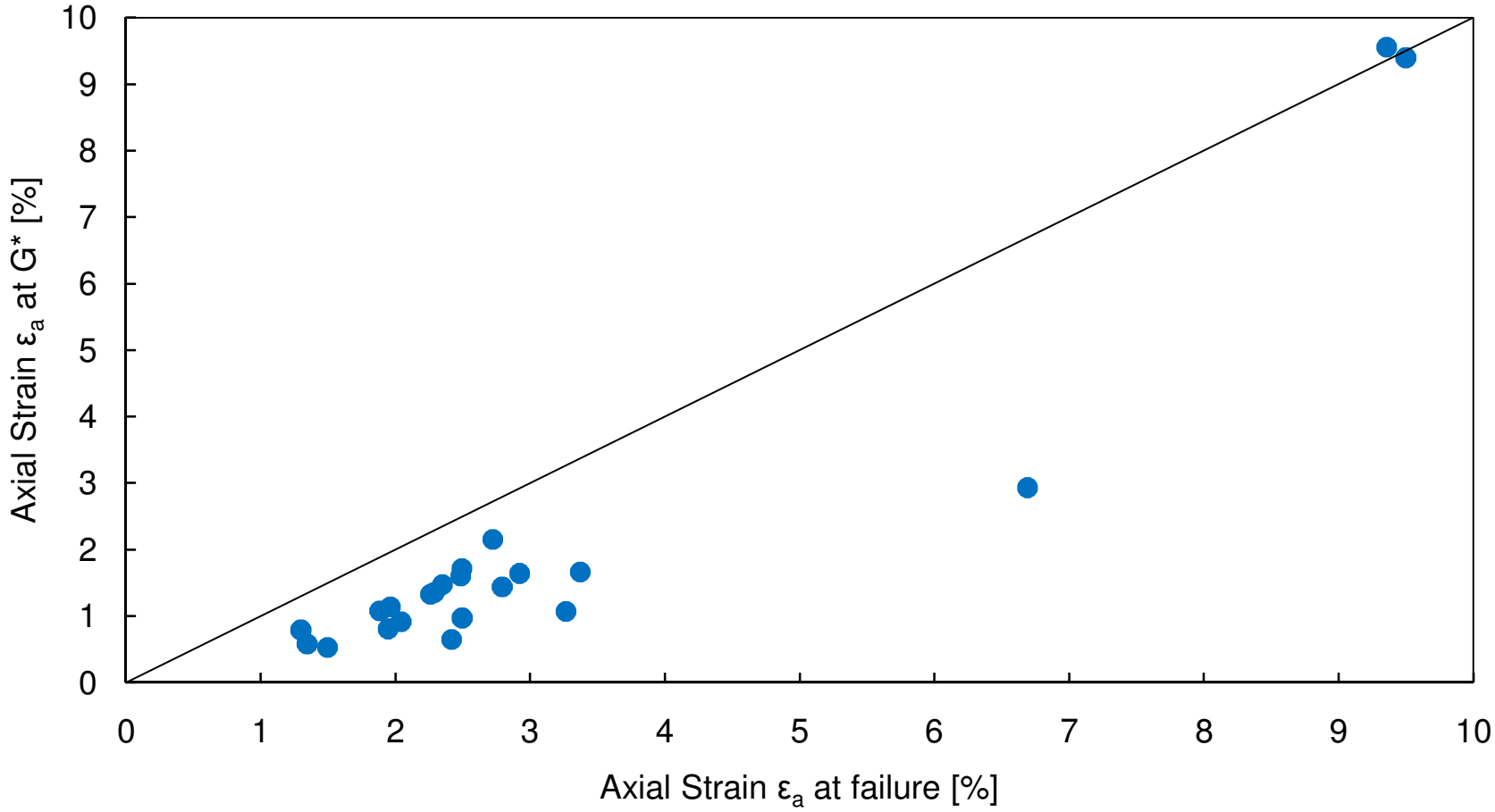


Shear wave velocity increased with σ_1' until the onset of bond breakage and destructuring and then decreased even as σ_1' increased to failure

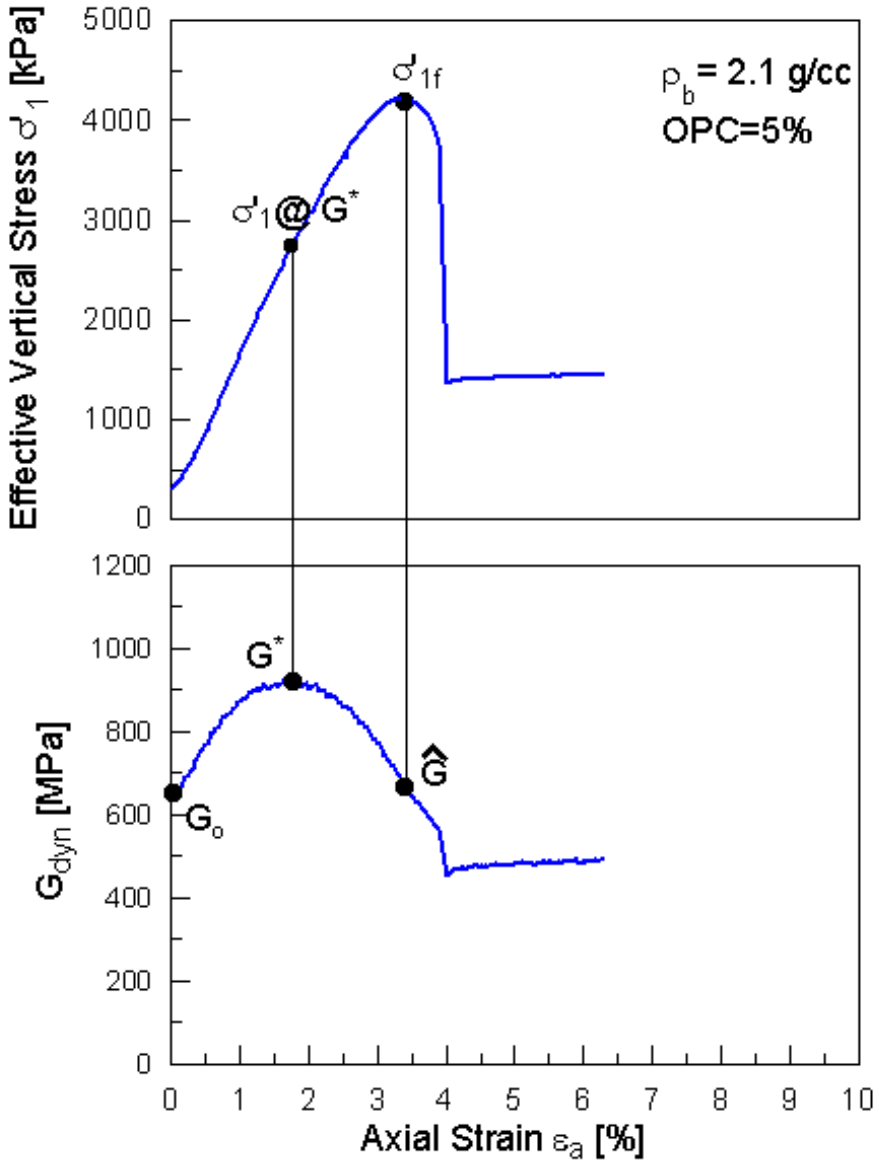




Comparison Between Axial Strain at Failure and Maximum Small Strain Shear Modulus



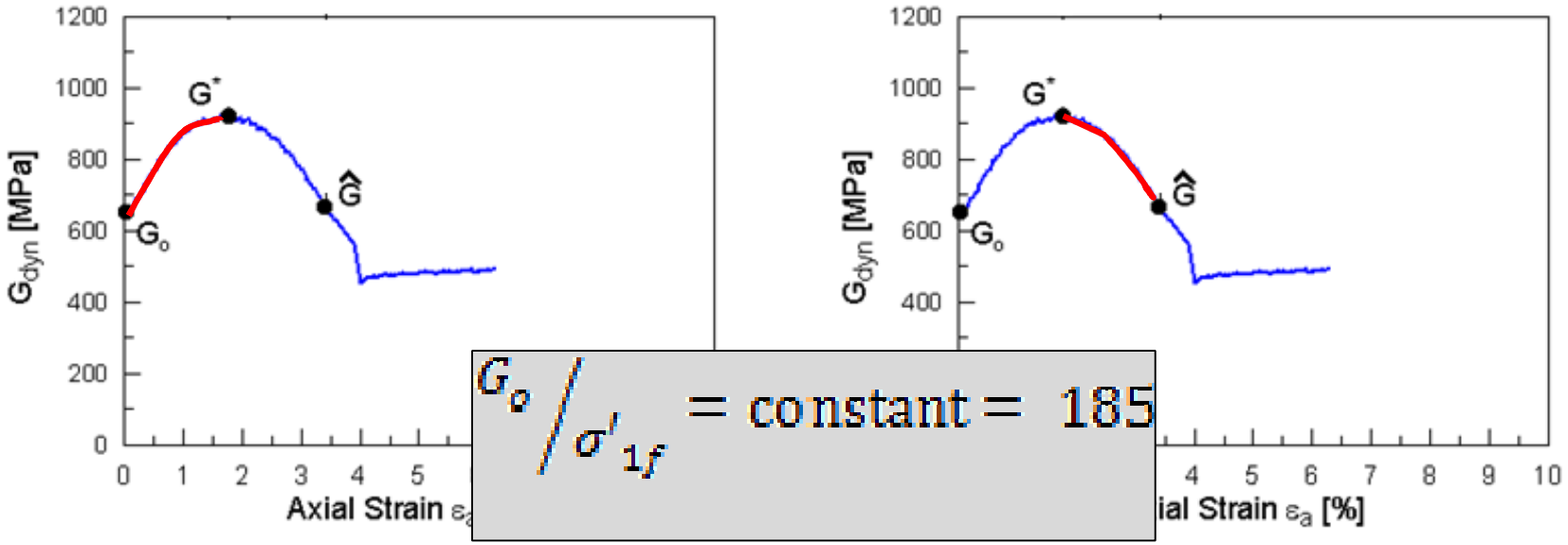
Relationship Between Small Strain Shear Modulus and Effective Stresses at Failure



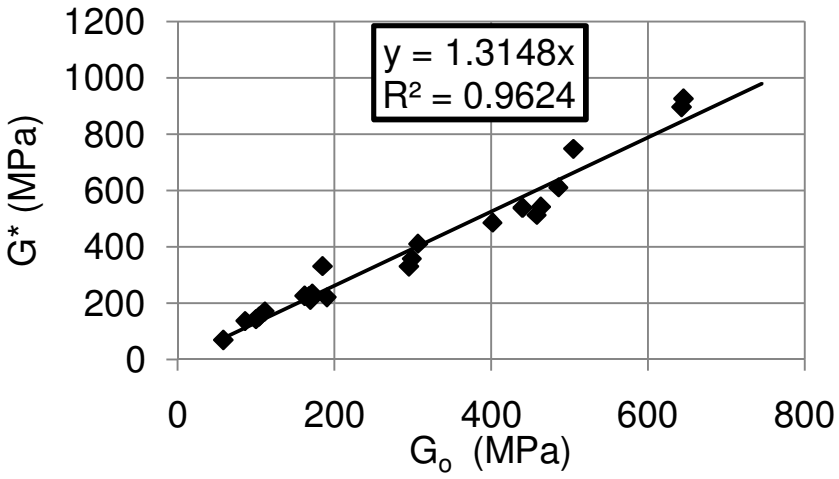
Hypothesis

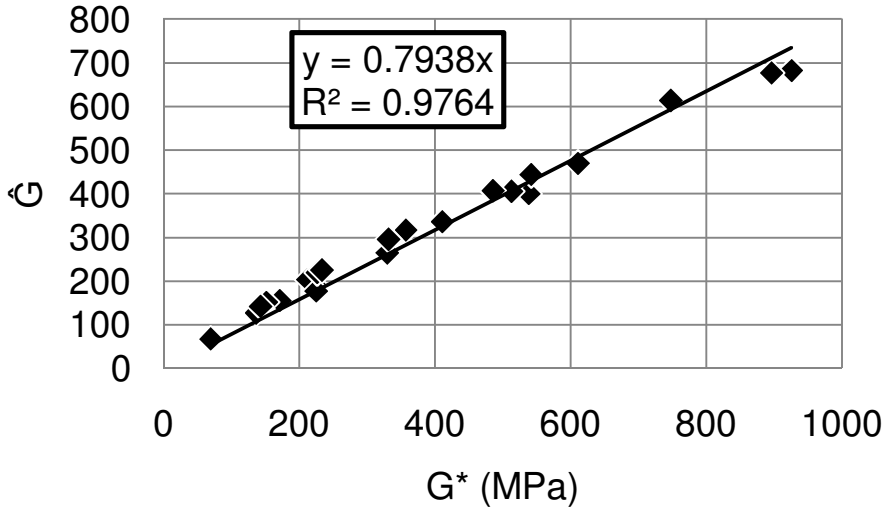
There is a unique relationship between the small strain shear modulus and effective stresses at failure for a given soil (i.e. G_o/σ_{1f}' = constant)

Relationship Between Small Strain Shear Modulus and Effective Stresses at Failure

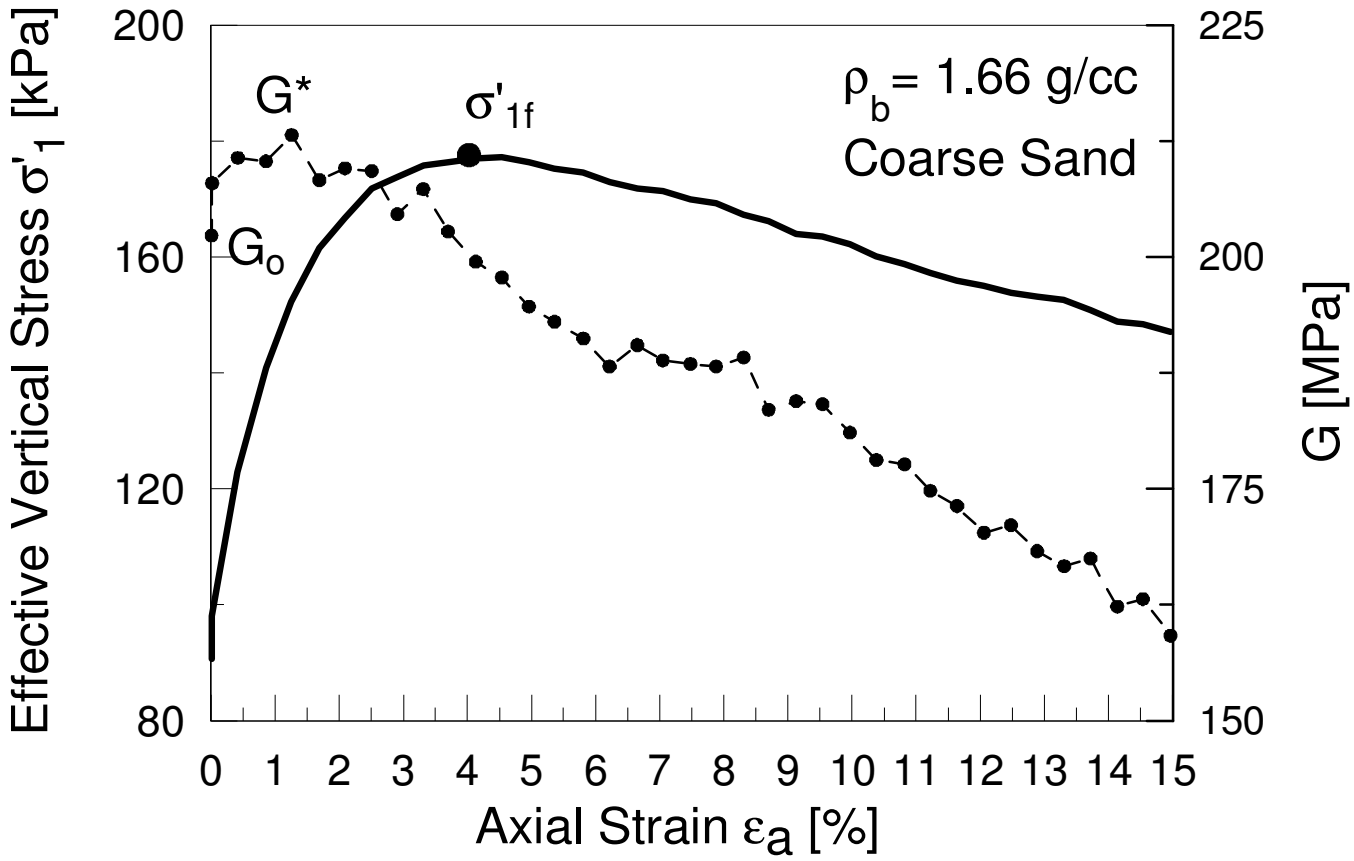


$$G_o / \sigma'_{1f} = \text{constant} = 185$$



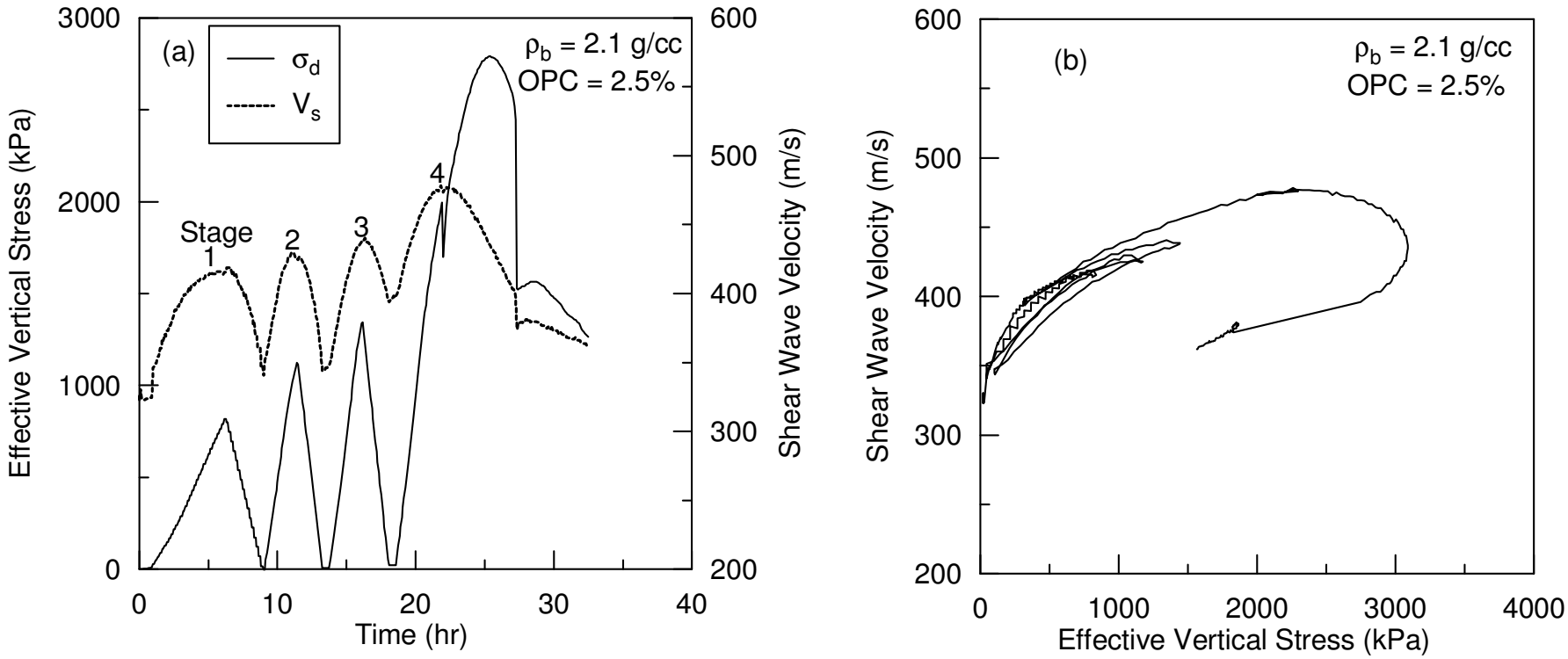


Does it work for Other Soils?



Implications

Multi-stage testing of sensitive soils (Sharma et al. 2011)



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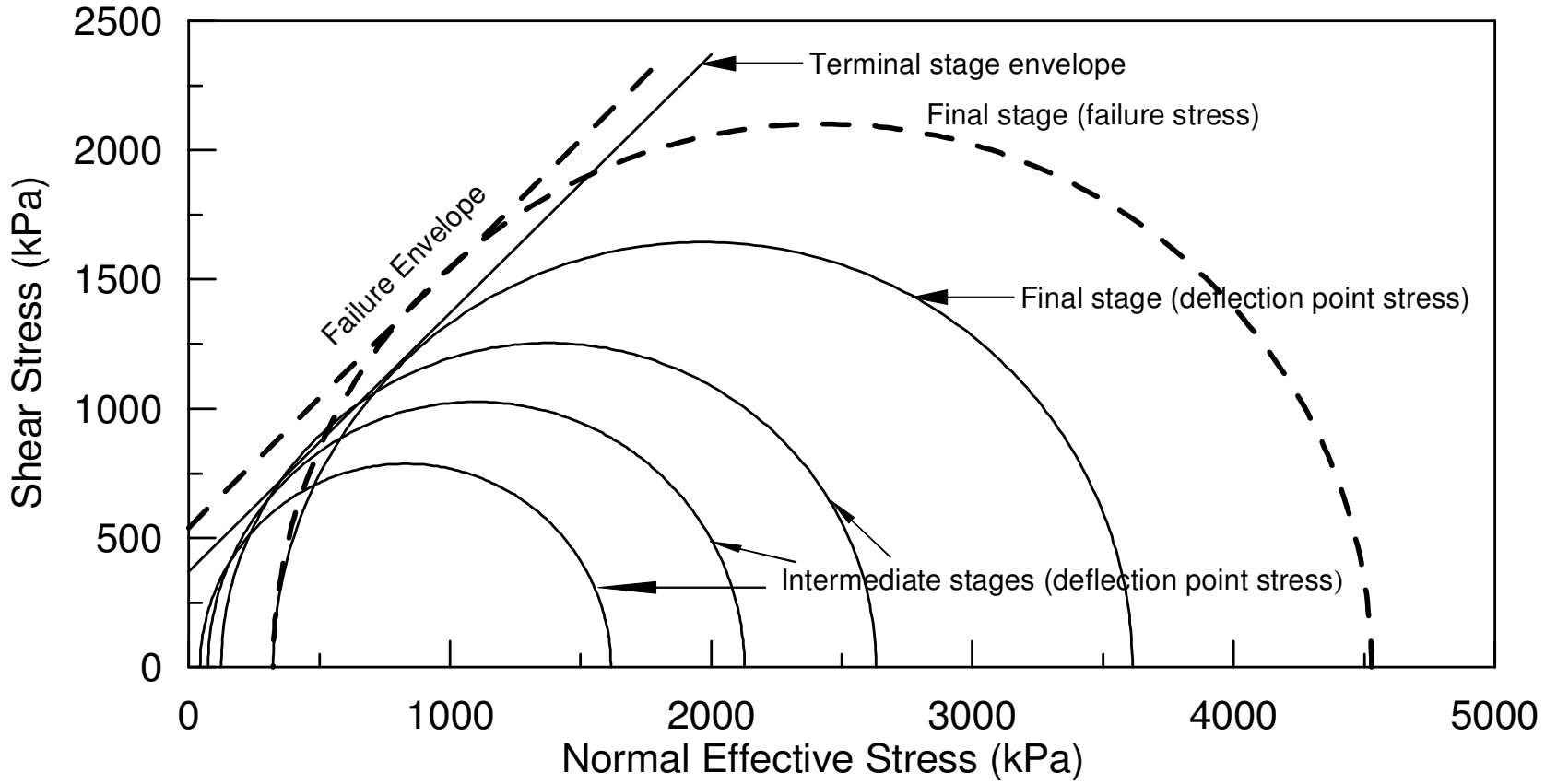
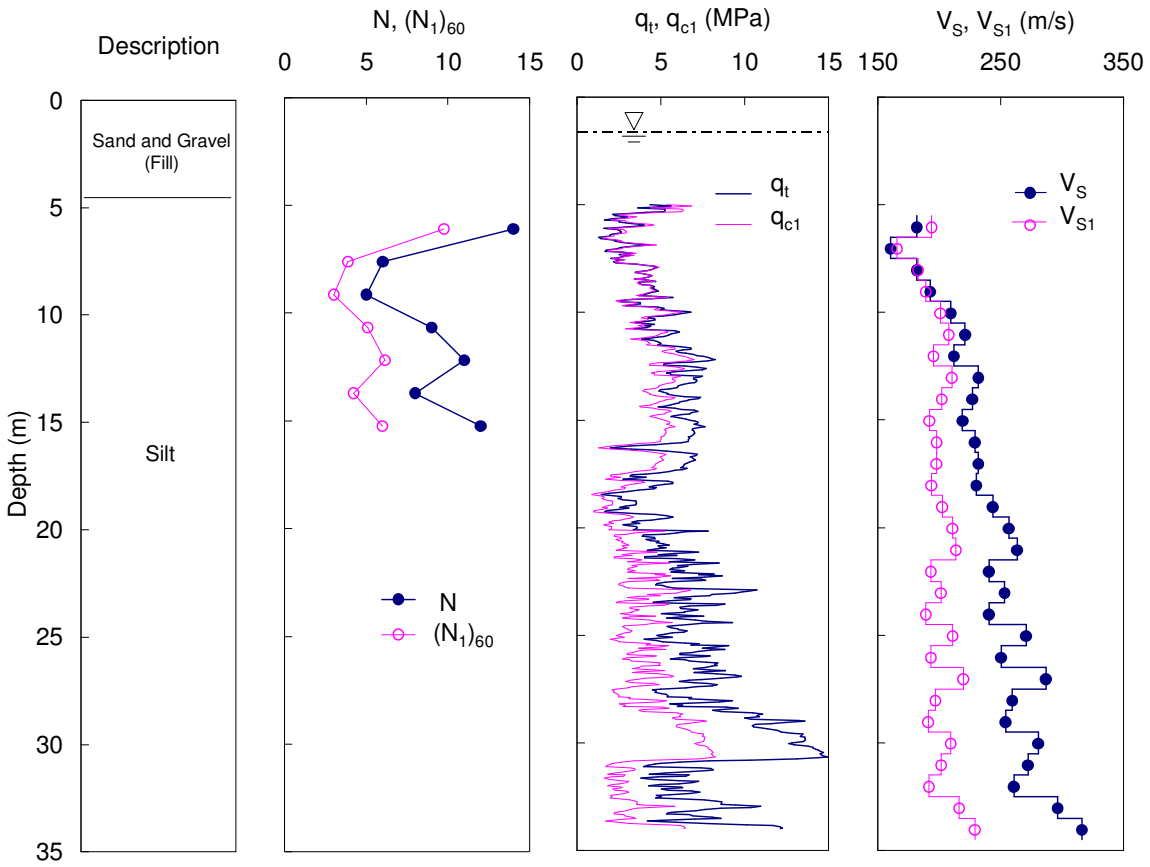


Other Possible Implications



- In situ estimates of ϕ'
- Early warning system for failure of sensitive or brittle soils

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Conclusions

- As part of a study on weakly cemented sands, 22 drained triaxial tests were performed on samples of silty sand of varying densities and degrees of cementation
- Shear wave velocity was measured continuously during shear using torsional shear transducers
- For 20 of the 22 samples, there was a unique relationship between the small strain shear modulus and effective stresses at failure for a given soil
- We hypothesize that G_o/σ_{1f}' = constant for dilative soils
- If proved to be true, then this may have important implications for determining strength parameters of hard to sample materials and possibly as an early warning system for failure in brittle materials

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