

Supplementary Materials

Supplementary Tables

Table S1. Empirical equations for estimating elastic modulus from SPT-N and CPT q_c values in sandy soils

Test Type	Equation	Unit	Reference
SPT	$E = 5(N_1)_{60} * P_a$	kPa	(Kulhawy and Mayne 1990a)
	$E = 383(N + 12)$	kPa	(Webb, 1970)
	$E_s^{4/3} = 4213N$	kPa	(Chaplin 1963)
	$E = 622(N_1)_{60}$	kPa	(Sabatini et al. 2002)
	$E = 450(N_{55} + 15)$	kPa	(Bowles 1996)
	$E_s = 1.5q_c, q_c > 2586 \text{ kPa}$	kPa	(Beer, 1965)
	$E_s = 3q_c, q_c < 2586 \text{ kPa}$		
CPT	$E_s = 2q_c$	kPa	(Schmertmann 1970)
	$E_s = 2.5q_c \text{ L/B} = 1 \text{ to } 2$	kPa	(Schmertmann et al. 1978)
	$E_s = 3.5q_c \text{ L/B} \geq 10$		
	$E_s = \alpha q_c \alpha = 3 - 12$	kPa	(Thomas 1968)
	$E_s = 2.5(q_c + 30)$	kPa	(Webb, 1970)
	$E_s = \alpha q_c$	kPa	(Sanglerat 1972)
	$\alpha = 2 \text{ for } q_c < 4788 \text{ kPa}$		
$\alpha = 1.5 \text{ for } q_c > 4788 \text{ kPa}$			

Supplementary Figures

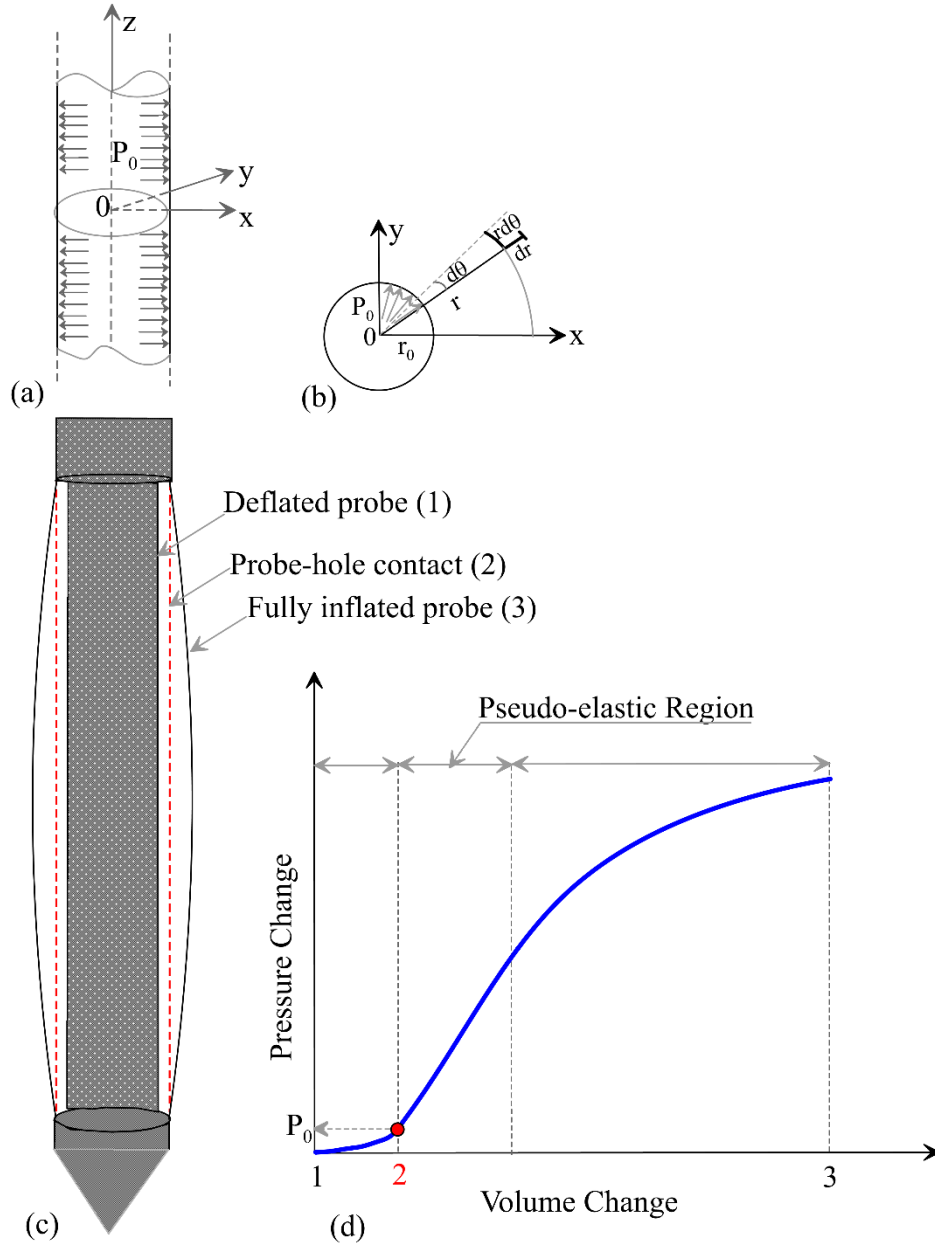


Fig. S1. Schematic of the PENCEL pushed-in pressuremeter (PPMT): (a) applied cavity pressure, (b) radial and circumferential (hoop) expansion around the probe, (c) probe inflation sequence from deflated to fully expanded states, and (d) idealized pressure–volume curve highlighting the pseudo-elastic region for modulus derivation (adapted from Briaud 1992, modified for PPMT).

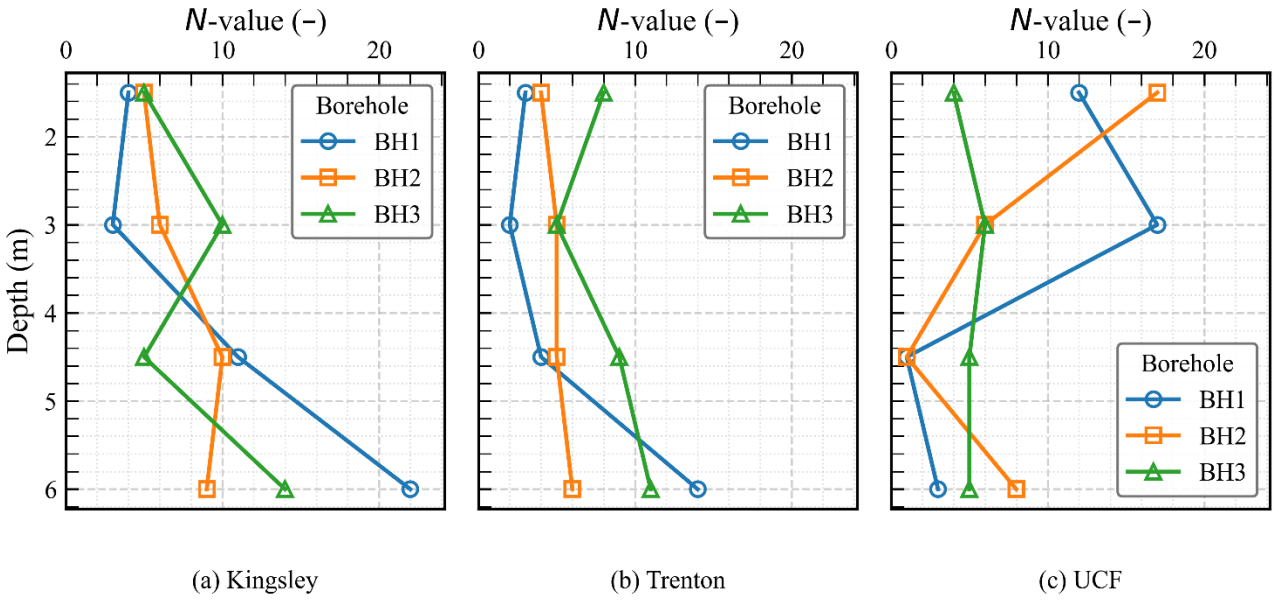
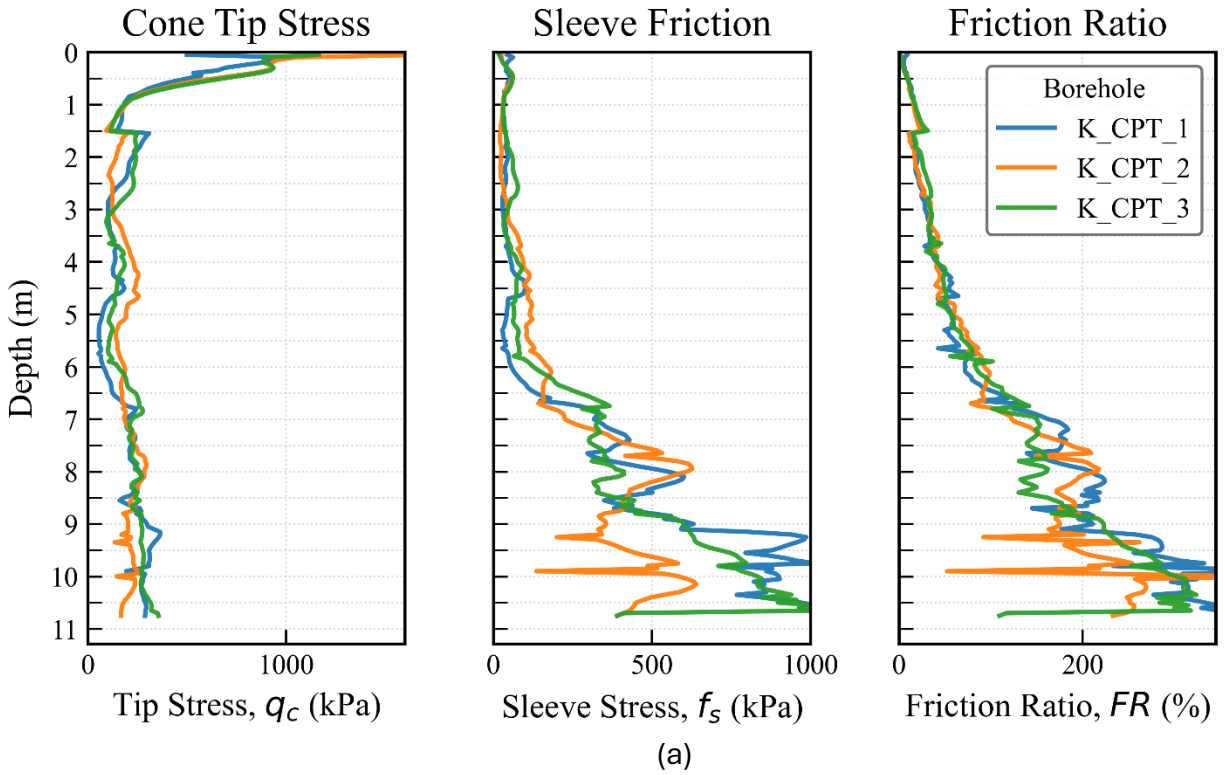
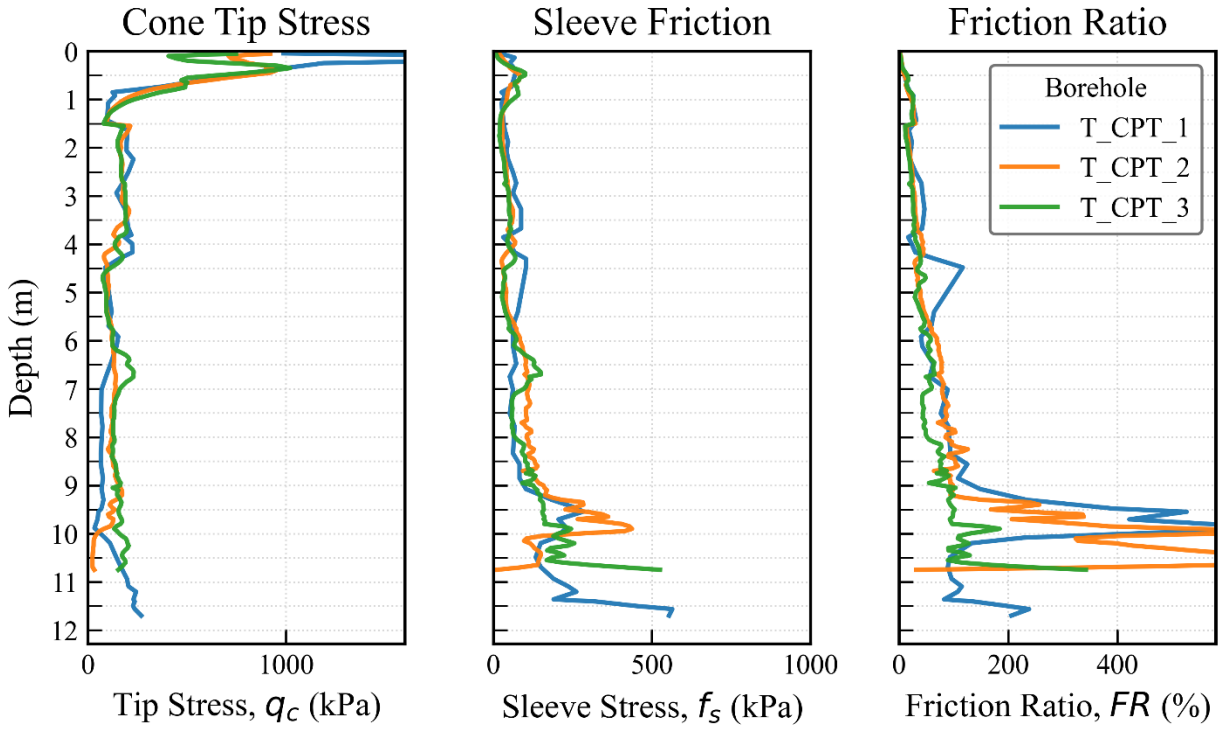
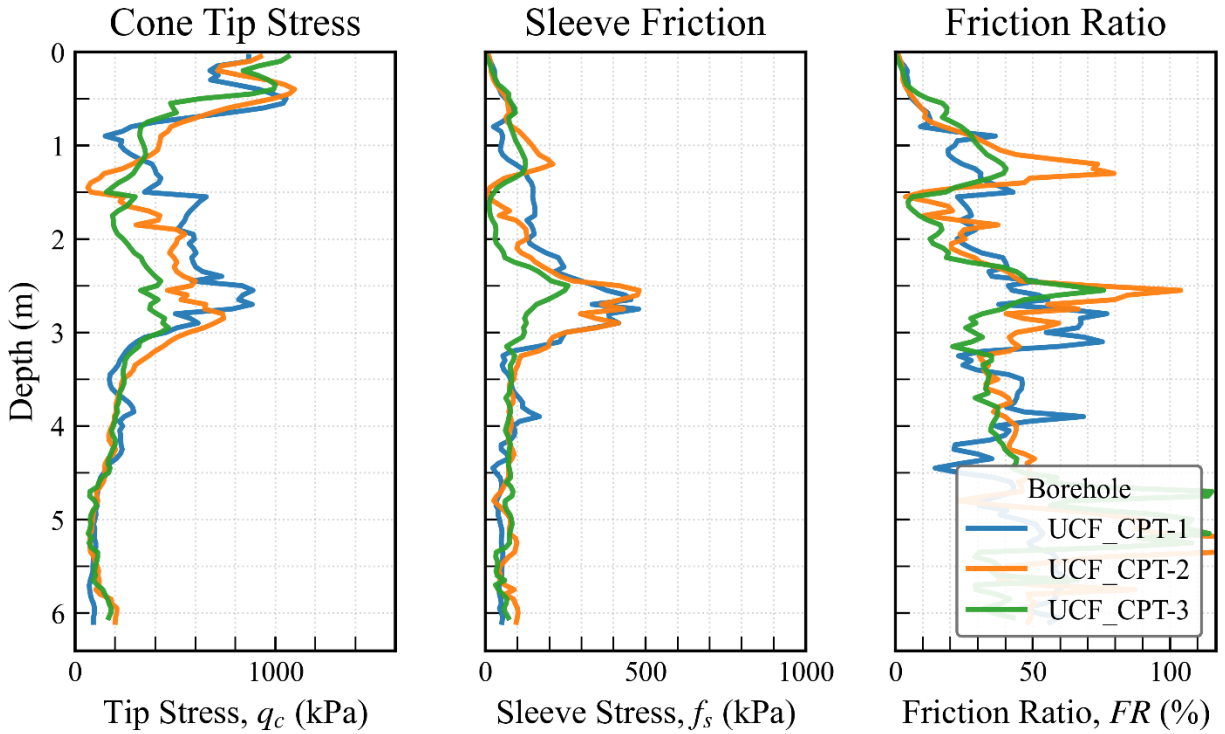


Fig. S2. Variation of SPT N -values with depth for (a) Kingsley, (b) Trenton, and (c) UCF.



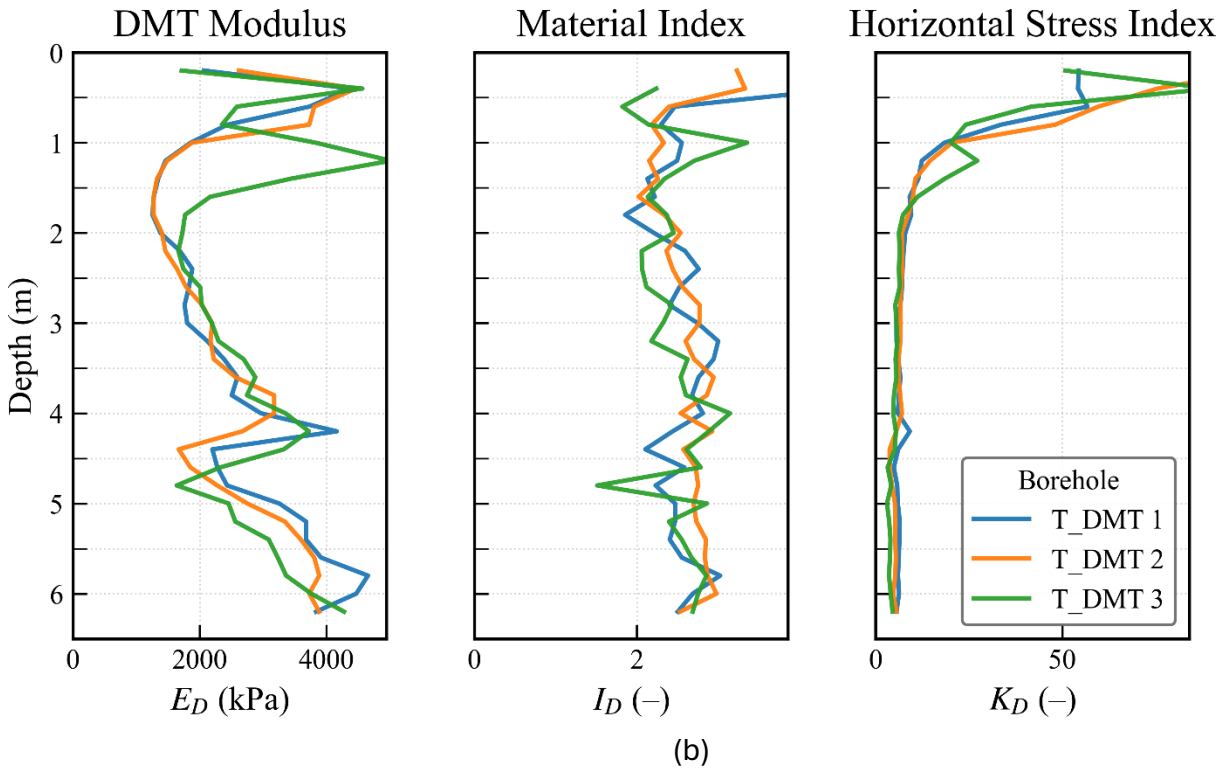
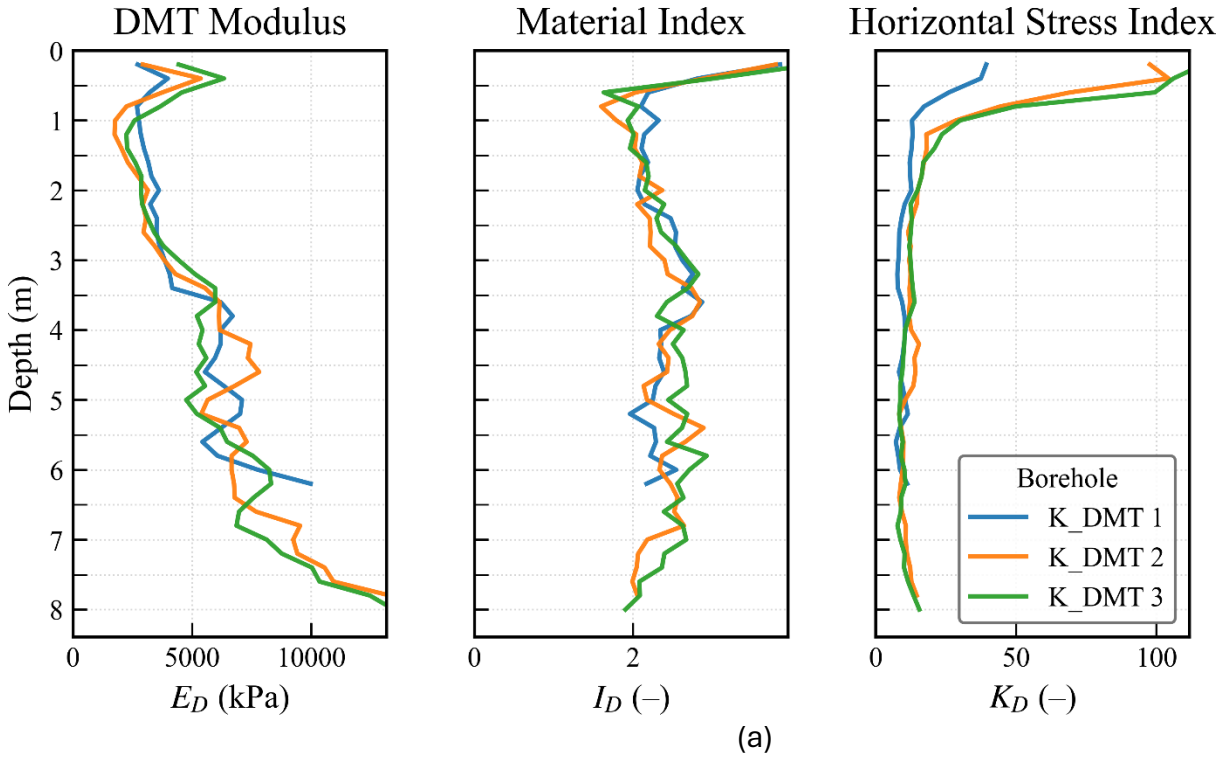


(b)



(c)

Fig. S3. CPT results for the (a) Kingsley, (b) Trenton, and (c) UCF sites showing q_c , f_s , and F_R versus depth.



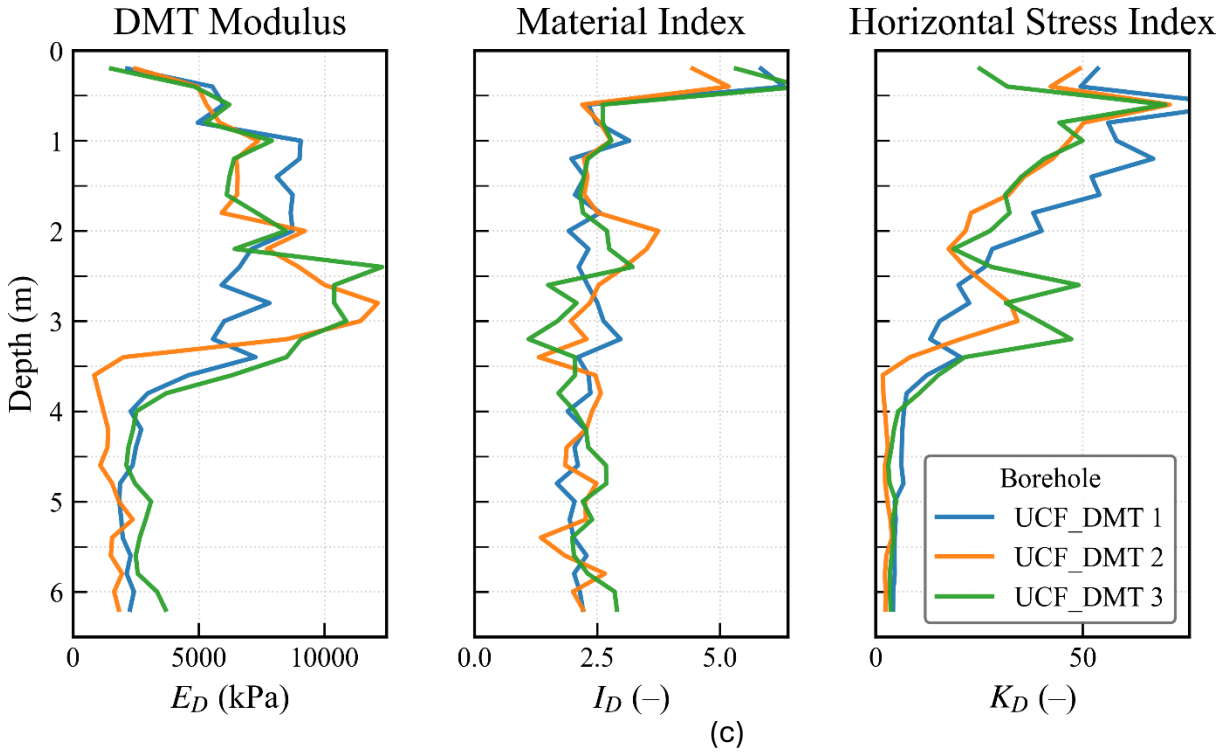
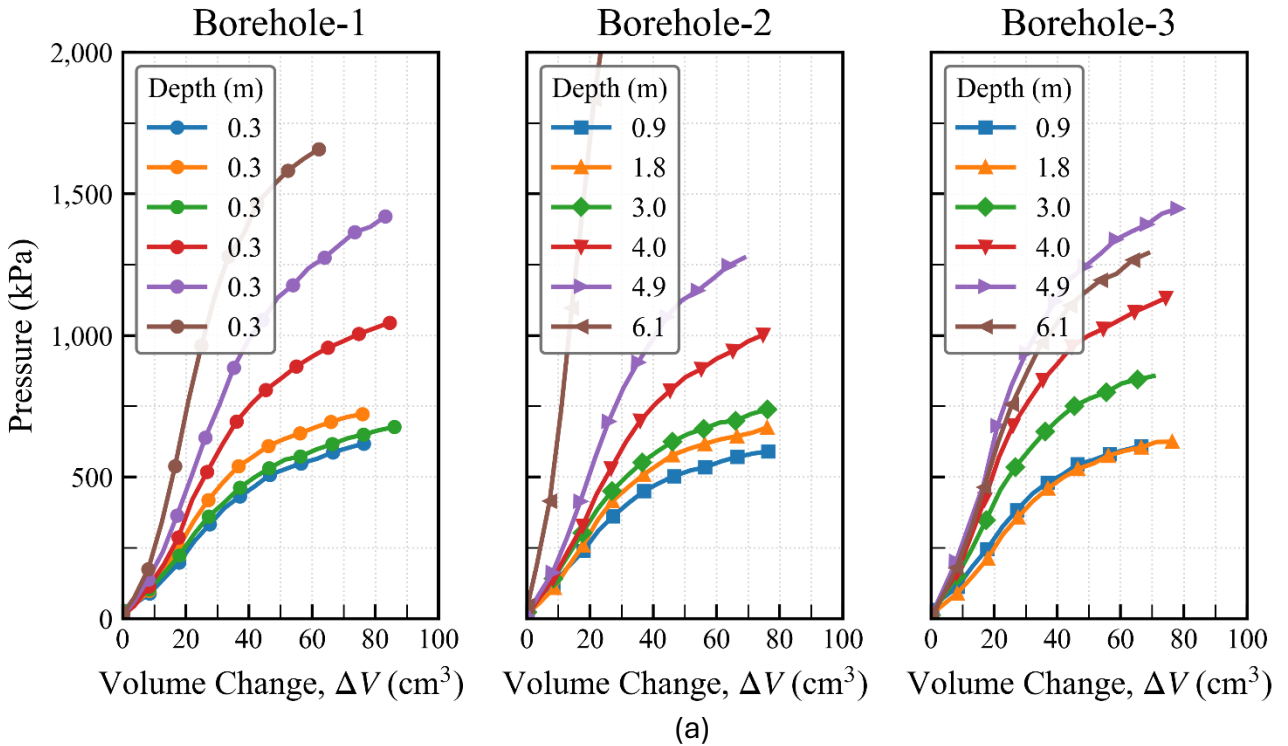
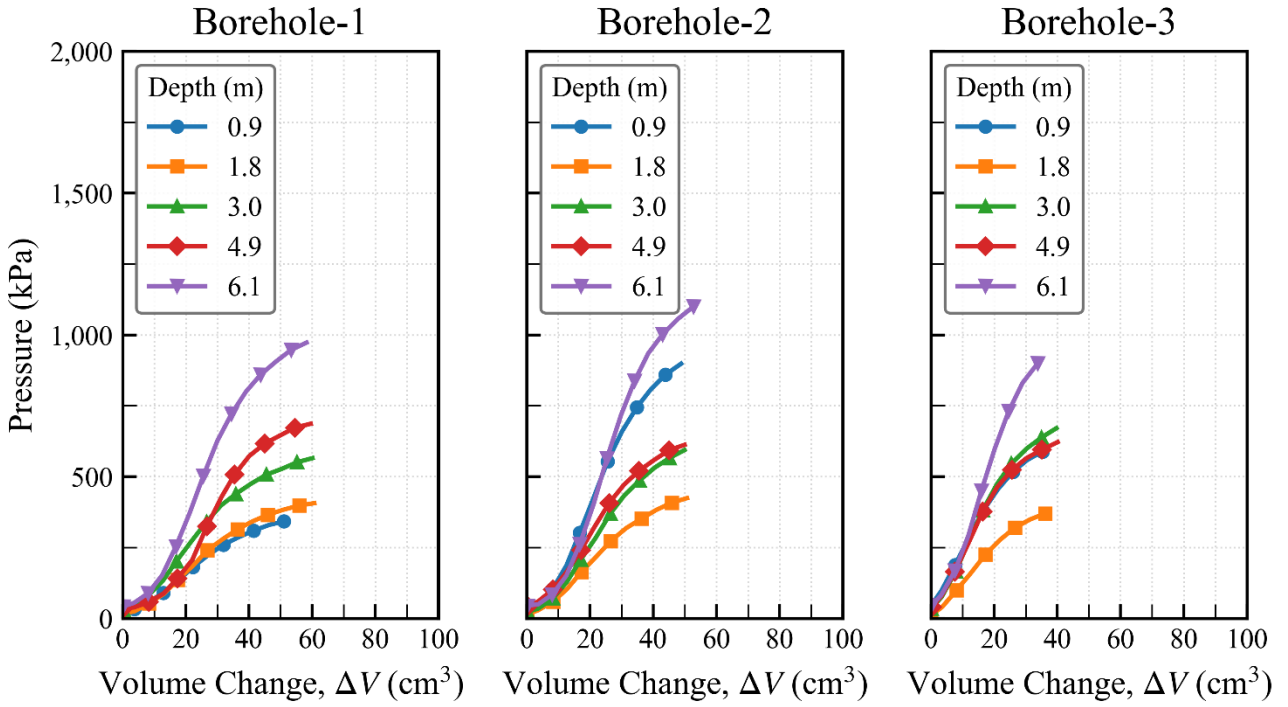
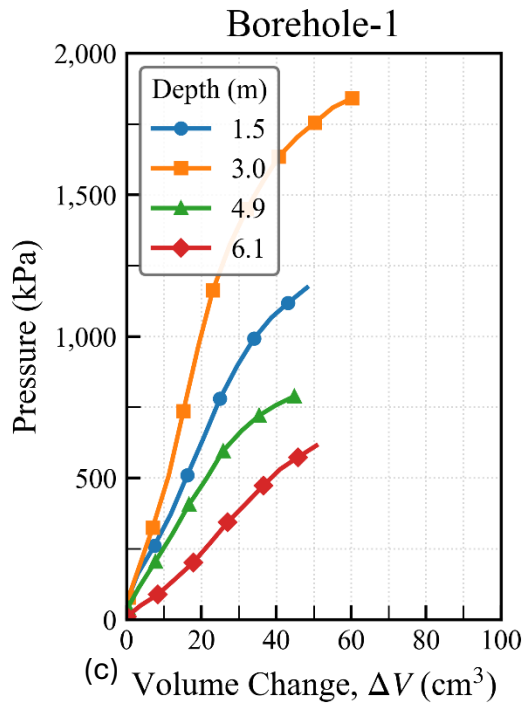


Fig. S4. DMT results show variation of E_{DMT} , I_D , and K_D with depth for (a) Kingsley, (b) Trenton, and (c) UCF sites.



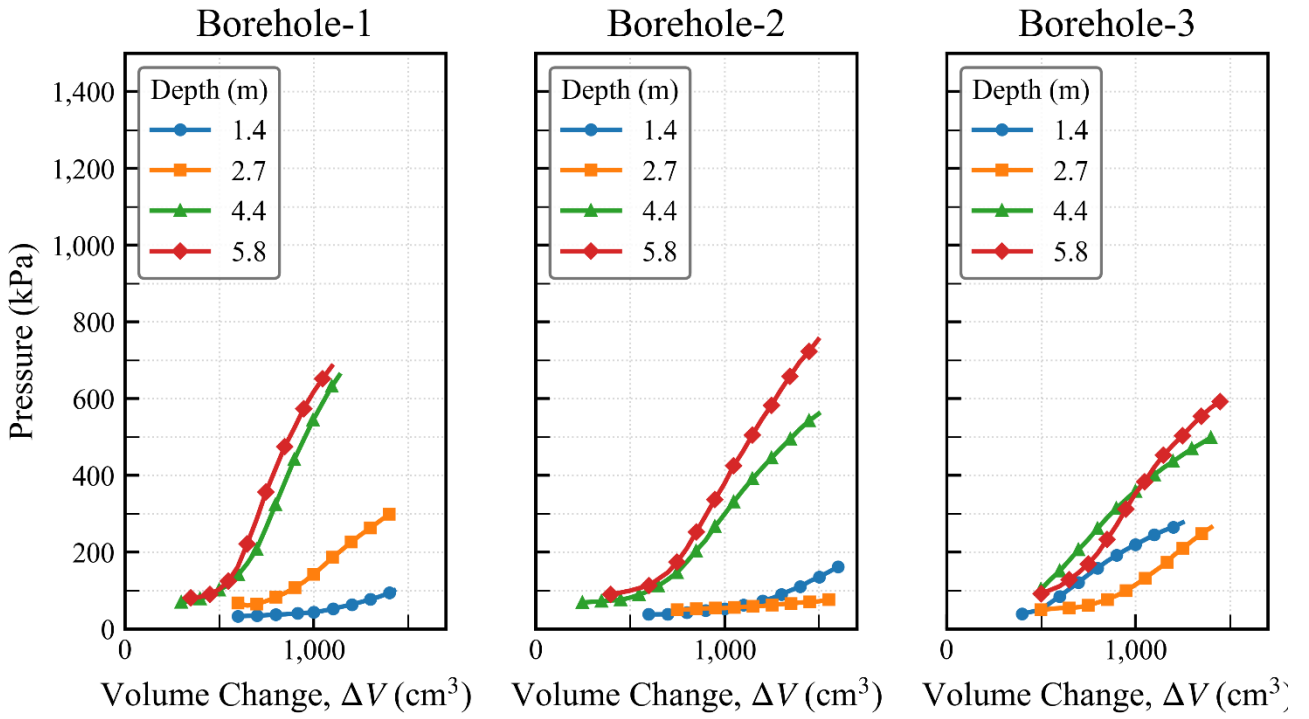


(b)

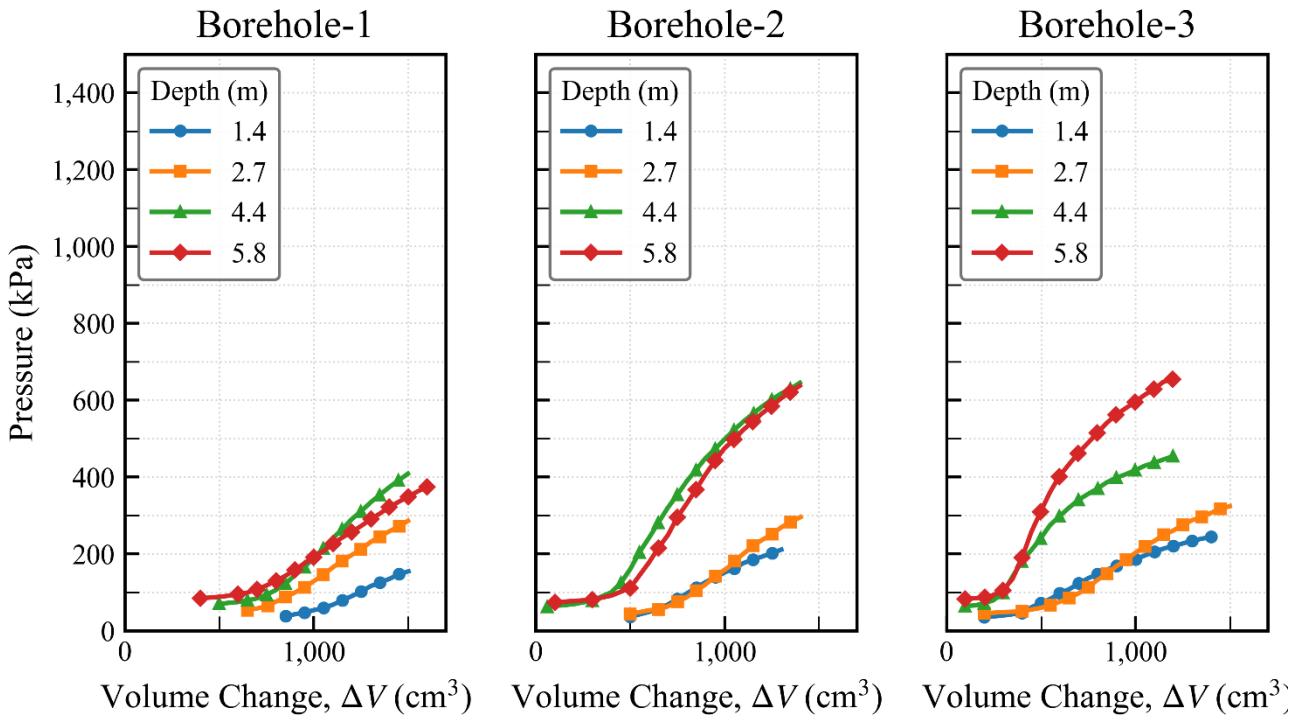


(c)

Fig. S5. Pushed-in PPMT pressure versus volume change expansion curves for multiple test depths at (a) Kingsley, (b) Trenton, and (c) UCF sites.



(a)



(b)

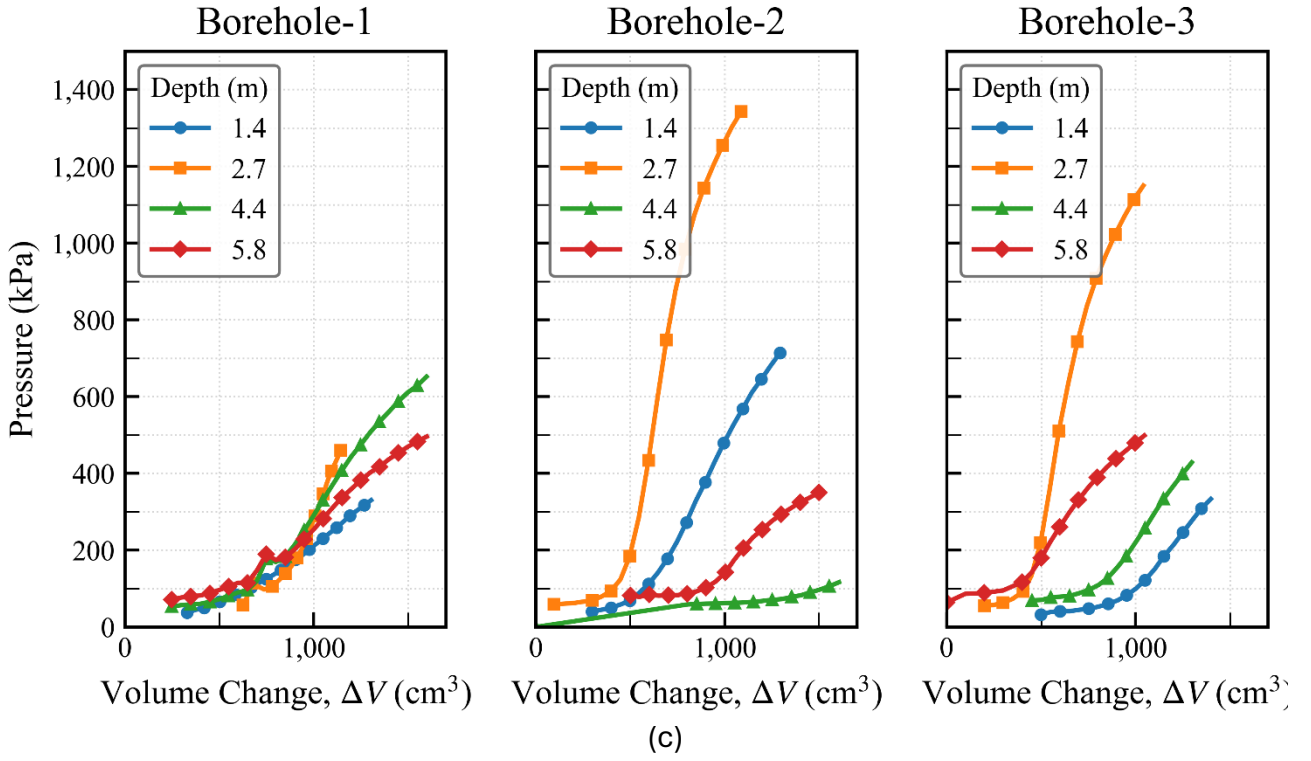


Fig. S6. TEXAM PMT pressure versus volume change expansion curves for multiple test depths at (a) Kingsley, (b) Trenton, and (c) UCF sites.

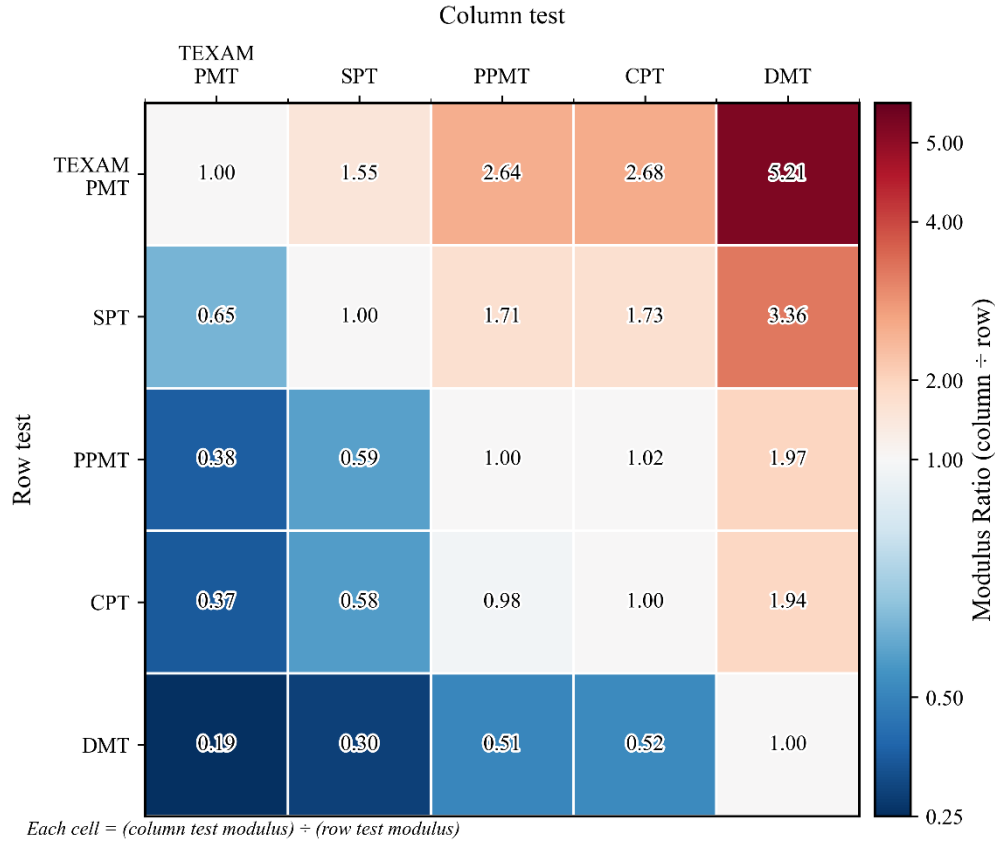


Fig.S7. Color coded map of average modulus ratios (E_{row}/E_{column}) across in-situ test types between 2–6.5 m depths; values near 1.0 indicate agreement in modulus magnitude.

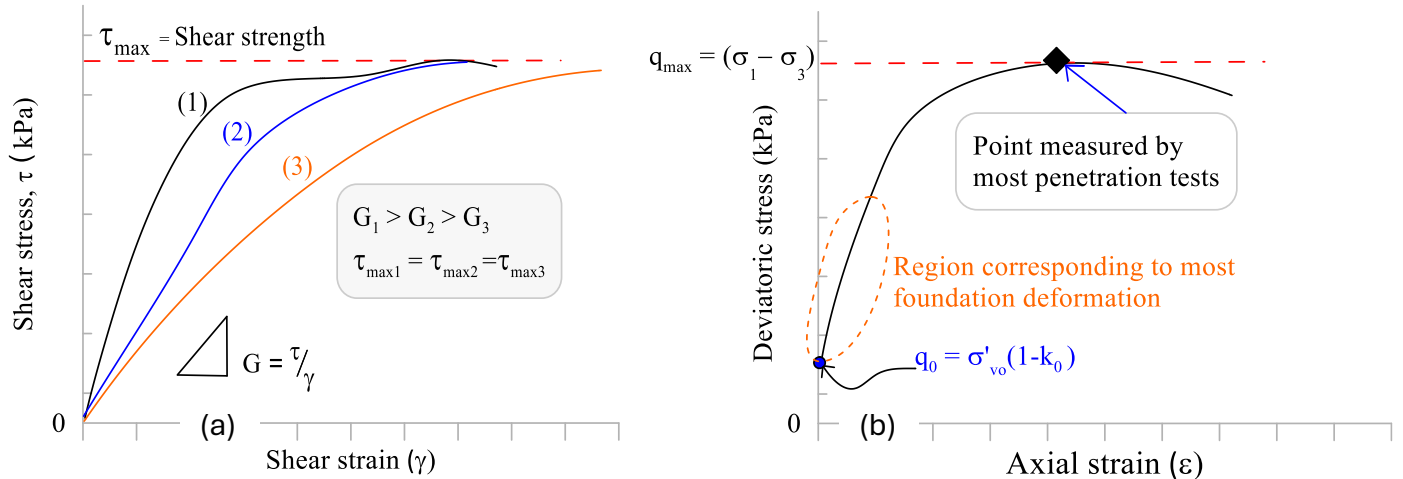


Fig. S8. (a) Stress-strain behavior for materials with identical strength but different modulus; (b) Modulus comparison by test type (adapted from Mayne (2001) and Sabatini et al. (2002)).

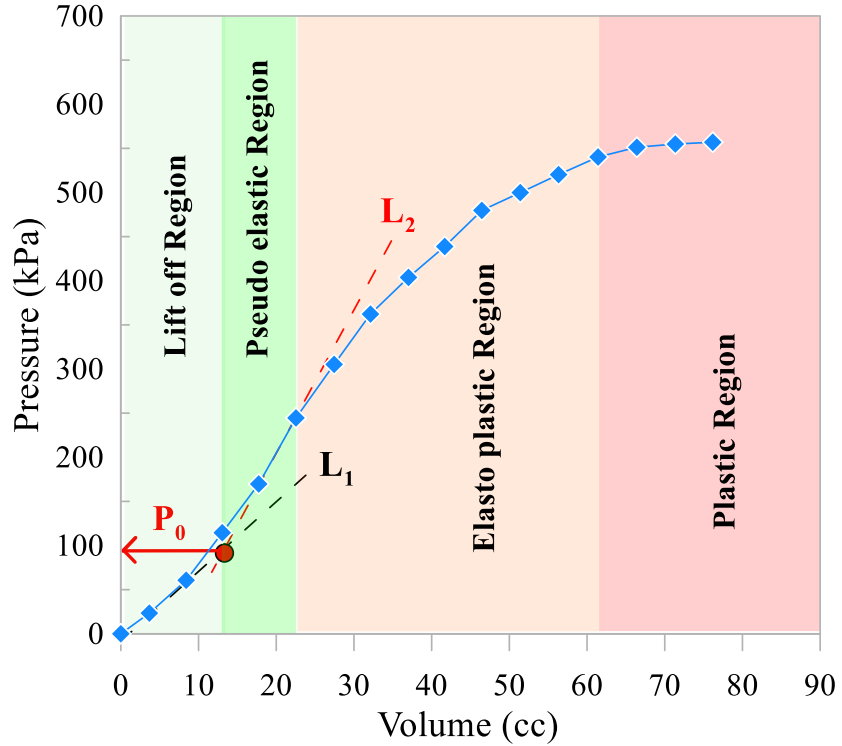


Fig. S9. Pressure–volume curve from PPMT showing contact pressure (P_0), pseudo-elastic region, and yielding. Tangents L_1 and L_2 identify the start of elastic response for modulus (E_0) derivation.

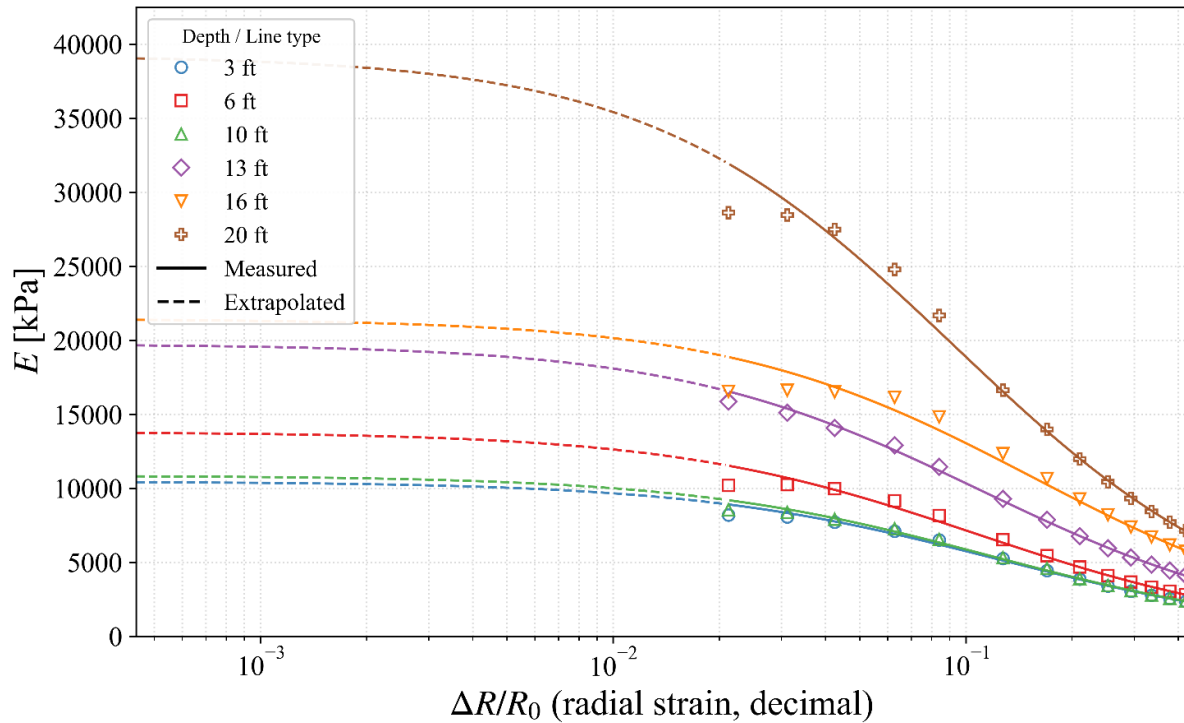


Fig. S10. Measured and extrapolated strain-dependent modulus degradation from PPMT tests across depths, showing a reduction in E with increasing radial strain.