CE394M: Stress-strain-strength relationship of clay

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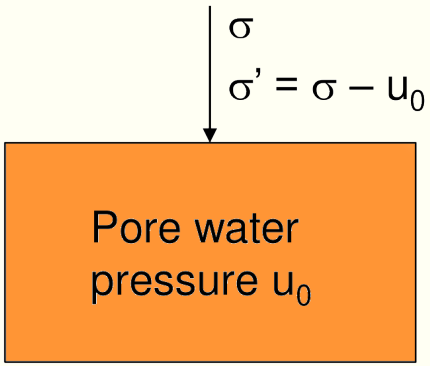
Overview

L-soil v D-soil

L-soils:

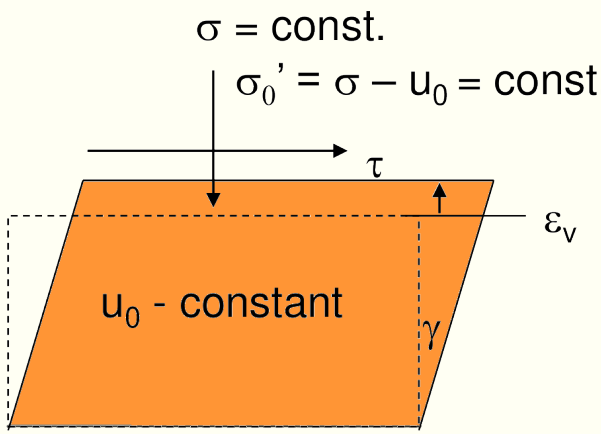
D-soils:

Simple shear



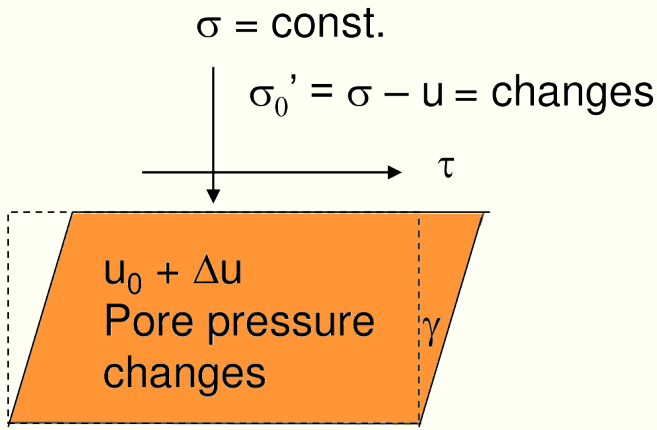
Initial consolidation
Void ratio e_0

Drained test



Change in void ratio
$\varepsilon_v = \Delta e/(1+e_0)$

Undrained test



No volume change

Simple shear: Normally Consolidated Clay - L-soil

NCL: L-soil (drained v undrained)

SS: LOC-soil (L-soils)

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SS: HOC-soil (D-soils)

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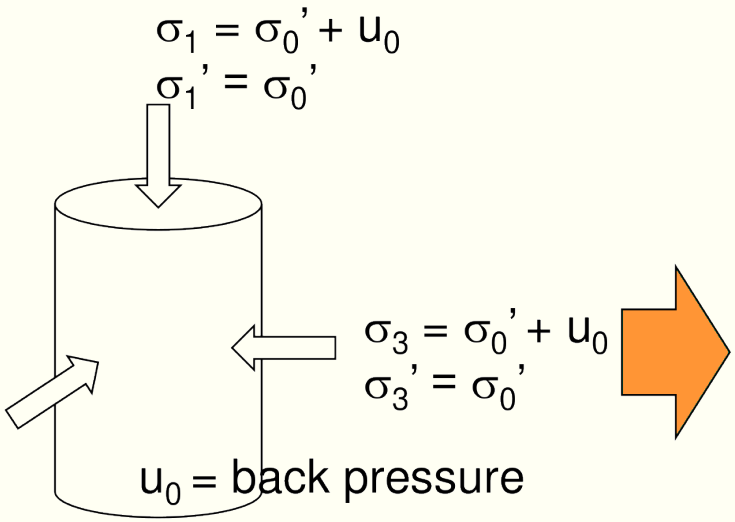
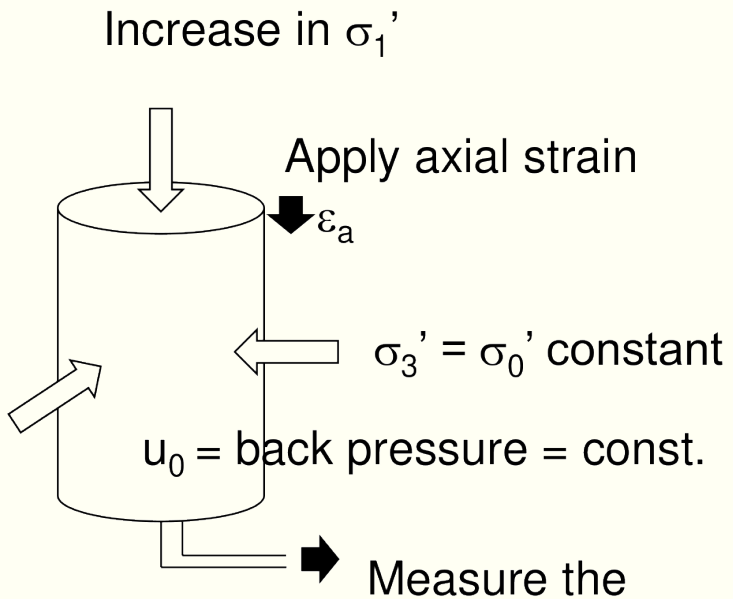
TXC: Drained strength and volume at failure using CS



Initial consolidation condition

$e_0 = Gsw_0$

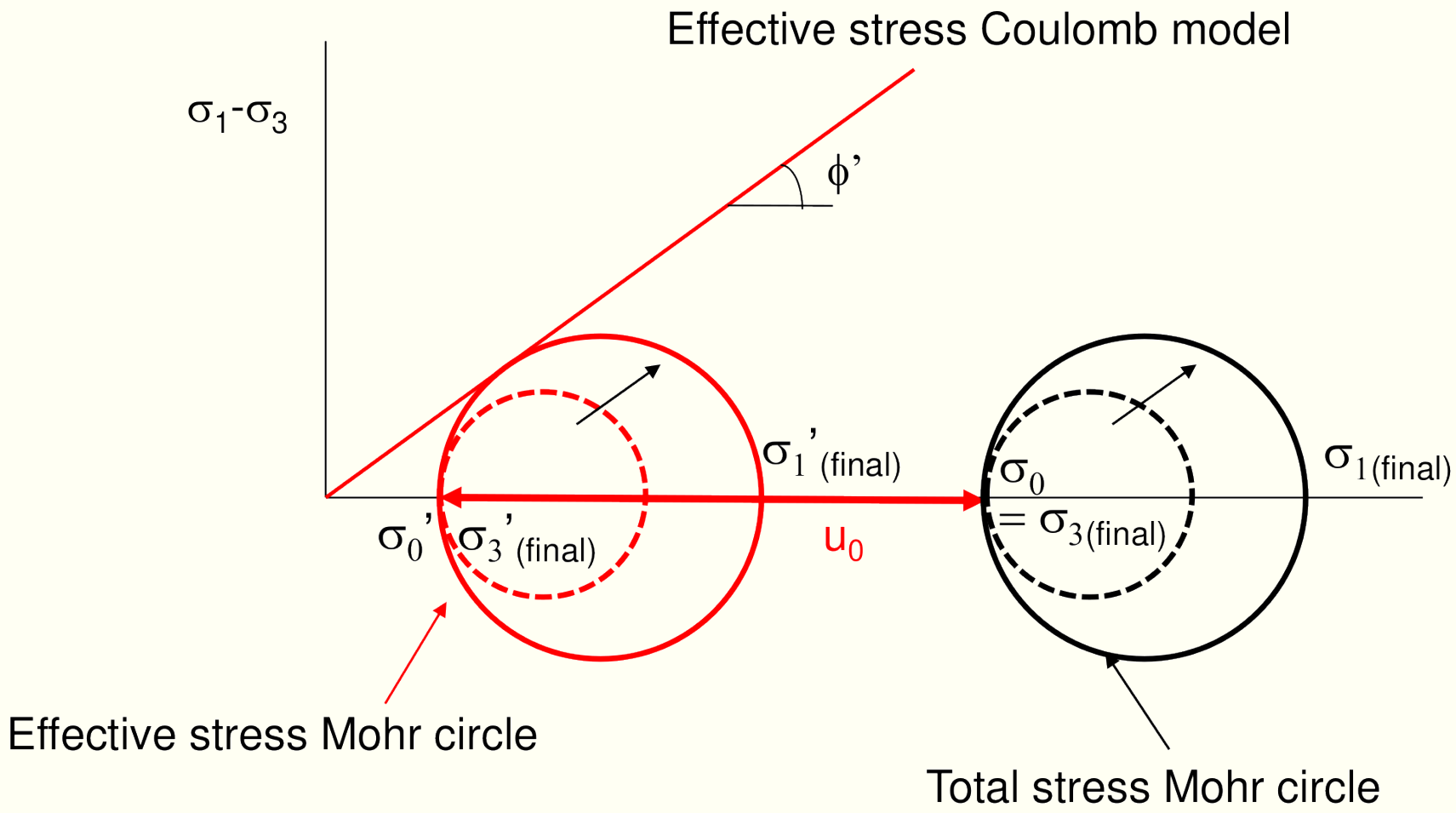


Measure the amount of water coming in or out

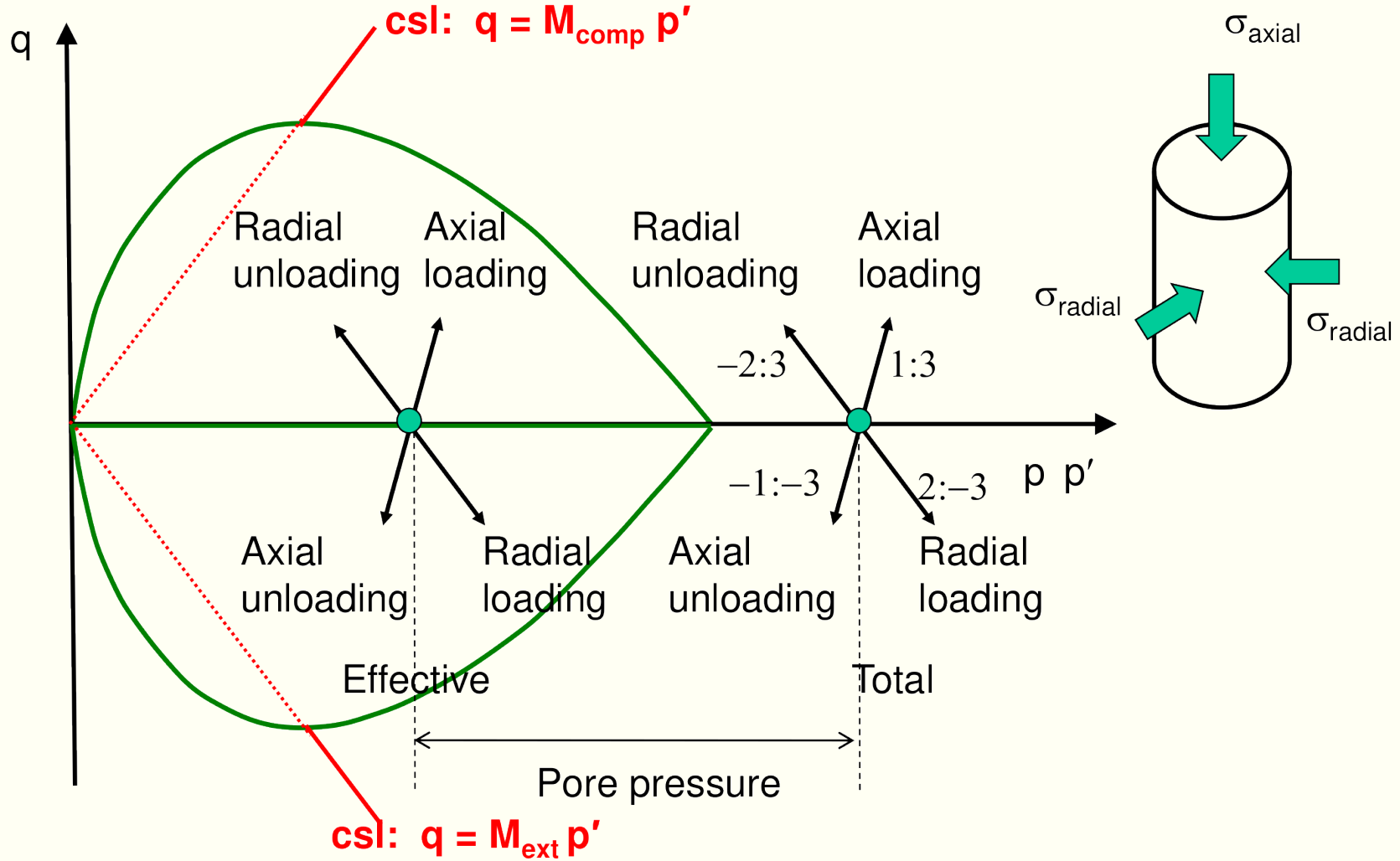
ε_v

Changes in void ratio $\varepsilon_v = de/(1+e_0)$

TXC: Drained (Mohr-Coulomb ESA)



TXC: Drained Cam-Clay yield and failure



TXC Drained (axial loading)

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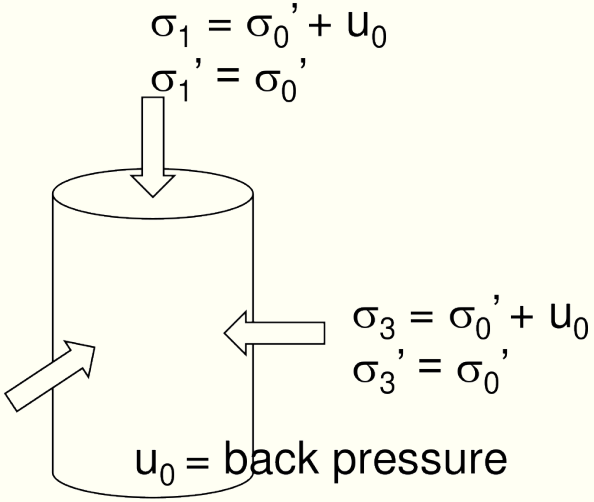
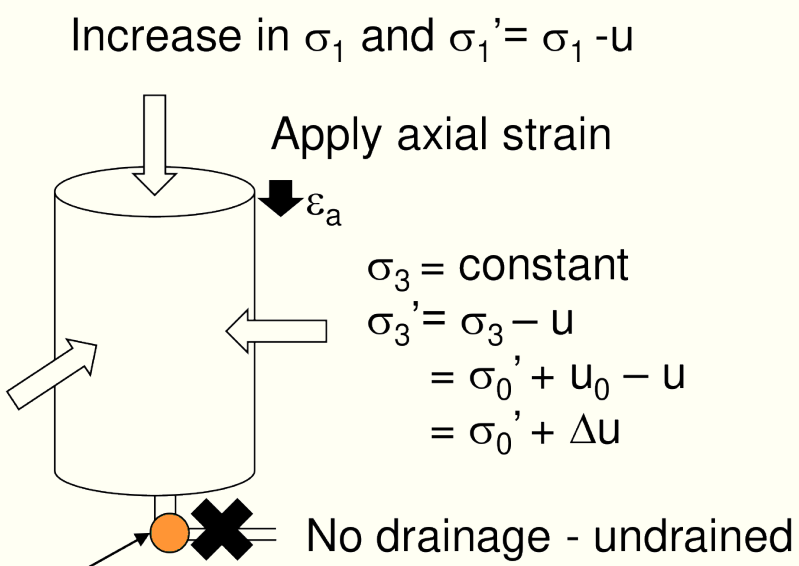
TXC: Undrained strength and excess PWP at failure





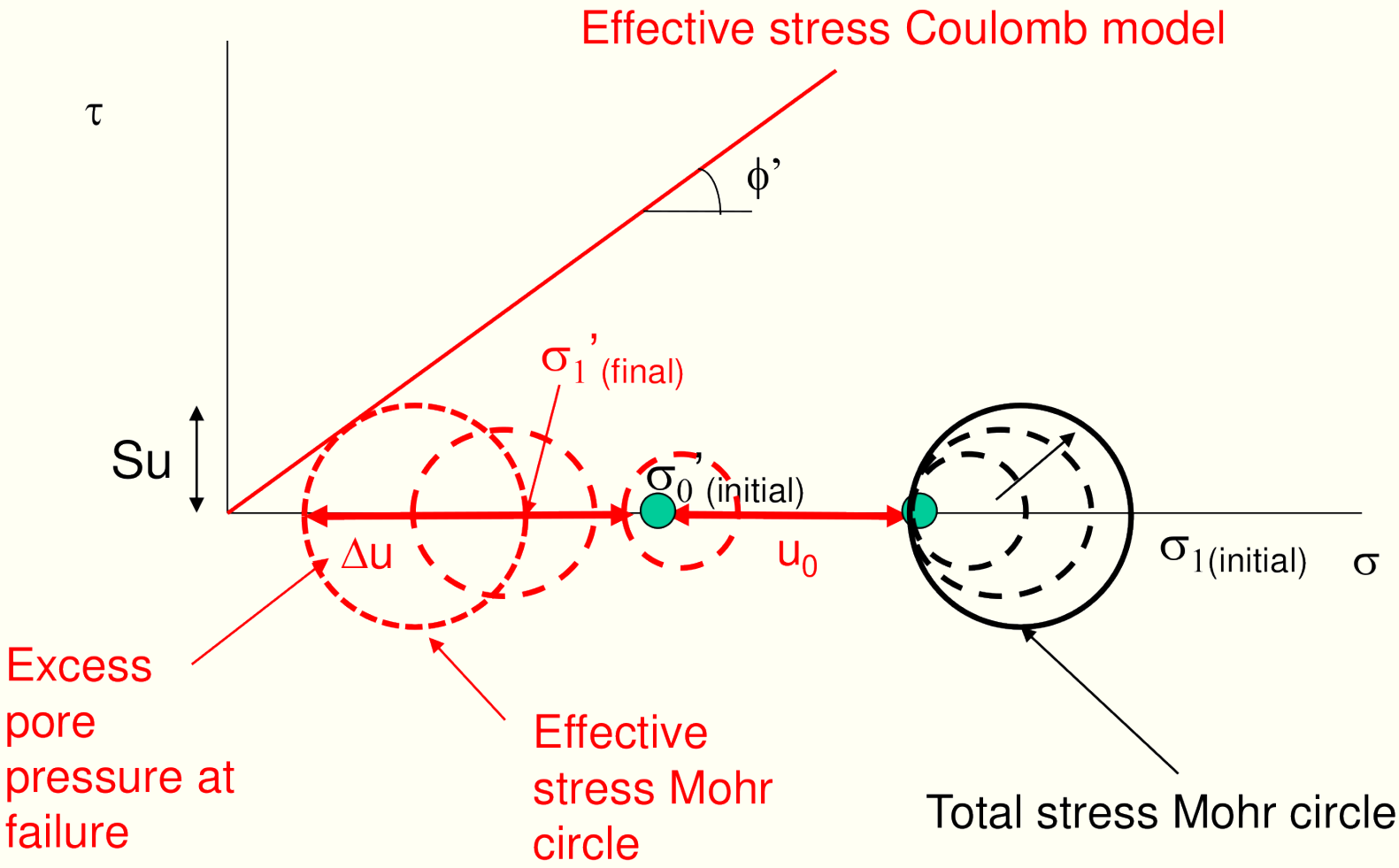
Initial consolidation condition

$e_0 = Gsw_0$

Excess pore pressure $\Delta u = u - u_0$

e_0 or w_0 is kept constant

TXC: Undrained (Mohr-Coulomb ESA)



TXC Undrained (axial loading)

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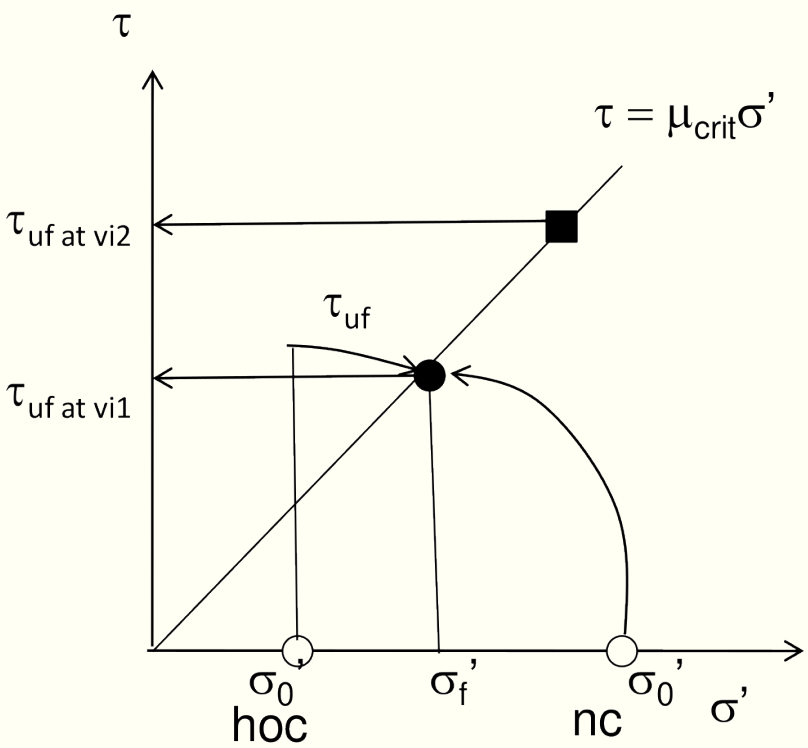
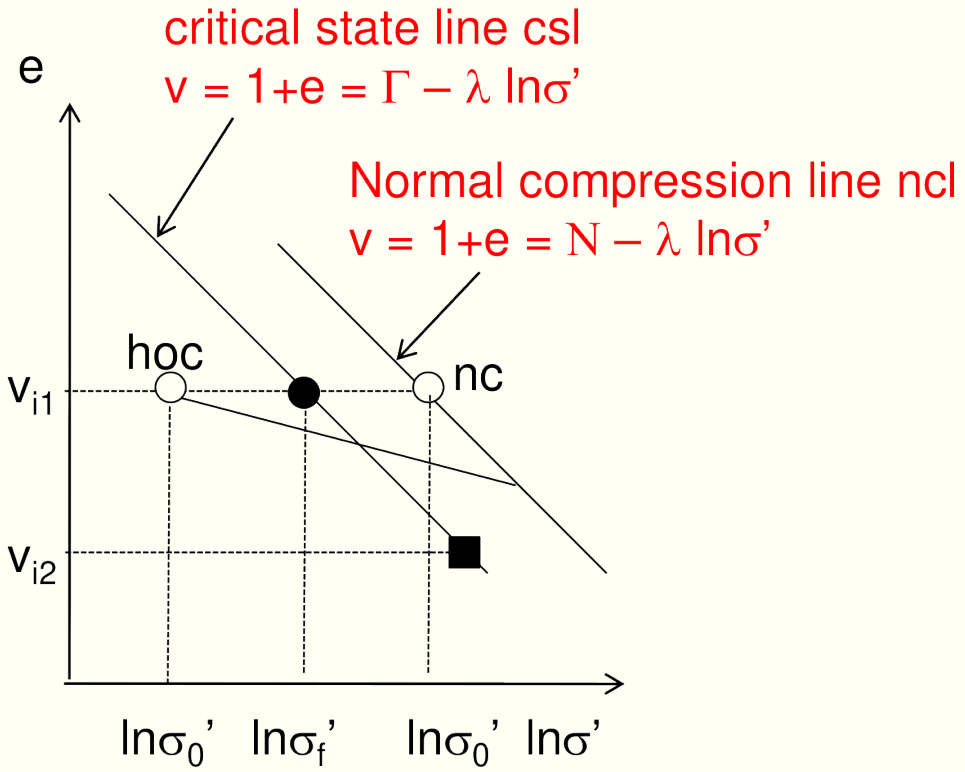
Critical state concept





Critical state concept

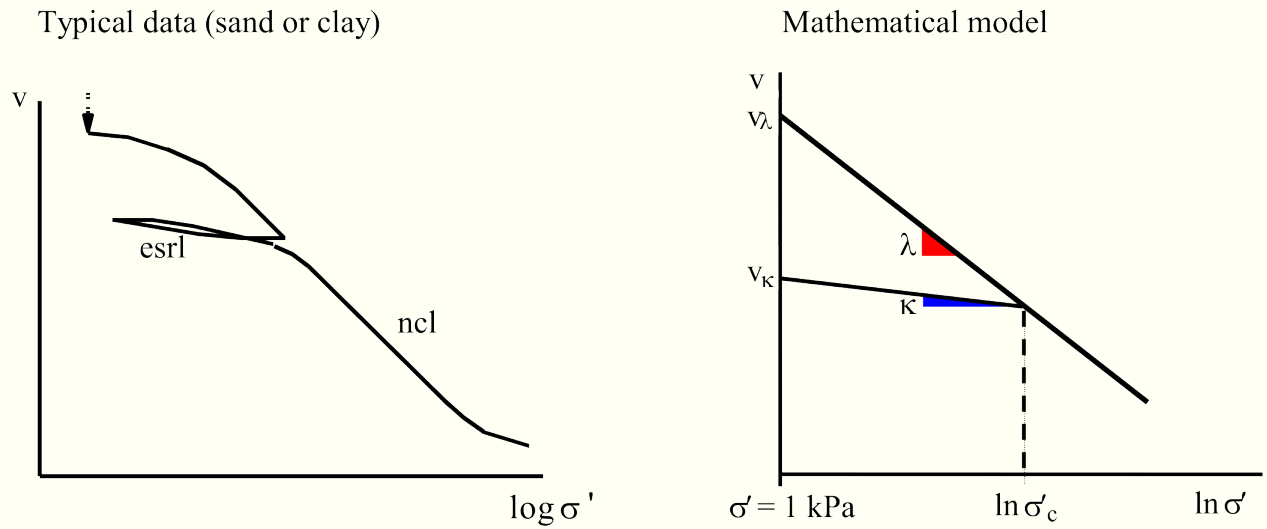
Interchangeable parameters for stress at yield and $d\varepsilon^p$.

System	Effective normal stress	Plastic normal strain	Effective shear stress	Plastic shear strain	Critical stress ratio	Plastic normal stress	Critical normal stress
General	σ^*	ε^*	τ^*	γ^*	μ^*_{crit}	σ^*_c	σ^*_{crit}
SSA	σ'	ε	τ	γ	$\tan\phi_{crit}$	σ'_c	σ'_{crit}
BA-PS	s'	ε_v	t	ε_γ	$\sin\phi_{crit}$	s'_c	s'_{crit}
TA-AS	p'	ε_v	q	ε_s	M	p'_c	p'_{crit}

Plastic work and dissipation: $\sigma^* \partial\varepsilon^* + \tau^* \partial\gamma^* = \mu^*_{crit} \sigma^* \partial\gamma^*$.

General yield surface: $\frac{\tau^*}{\sigma^*} = \mu^* = \mu^*_{crit} \ln\left[\frac{\sigma^*_c}{\sigma}\right]$

Critical state concept: 1D compression



Plastic compression stress σ'_c is taken as the larger of the initial aggregate crushing stress and the historic maximum effective vertical stress. Clay muds are taken to begin with $\sigma'_c = 1$kPa.

Plastic compression (normal compression line): $v = v_lambda - \lambda \ln \sigma'$ for $\sigma' = \sigma'_c$.

Elastic swelling and recompression line ($\kappa-$line): $v = v_c + \kappa(\ln \sigma'_c - \ln \sigma'_v)$.