Period #24: Shear Strength of Soils (IV)

A. Review and Motivation

- The Mohr–Coulomb shear strength model for soils is of the form:

$|\tau_f| = c + \sigma'_n \tan(\varphi_D)$ where:

$\lvert \tau_f \rvert$	is the absolute value of shear stress that causes failure on a given plane;
$c \geq 0$	is the cohesion of the soil;
σ'_n	is the normal **effective** stress on a plane; and
$\varphi_D \geq 0$	is the so–called **drained** angle of friction for a soil.

Typically, one does not expect to see a value of φ_D greater than about 45^o.

- Note that in the above shear strength criterion, the normal stresses are always effective stresses.
- For saturated, fine–grained soils subjected to loads, the effective stresses change over long periods of time as excess pressures dissipate.
- Therefore, the shear strength of a saturated, fine–grained soil will generally change (increase) with time as excess pore pressures dissipate.
- This period, we discuss different strength models for fine–grained soils that are based on combinations of total stresses and effective stress.
  - Typically, models based on effective stresses, apply to the long term drained behavior of fine–grained soils.
  - Models based on total stresses typically apply to short–term behaviors such as in the first few weeks/months after a structure is built upon a fine–grained soil deposit.

B. Drained Shear Strength Behavior of Clays

- For normally consolidated clays, $c \approx 0$, and the friction angle is denoted φ_D.
- For over−consolidated clays, $c > 0$, and the friction angle is denoted by φ_{D-1}.
- When the soil is overconsolidated: (or when $\sigma' < \sigma'_c$)

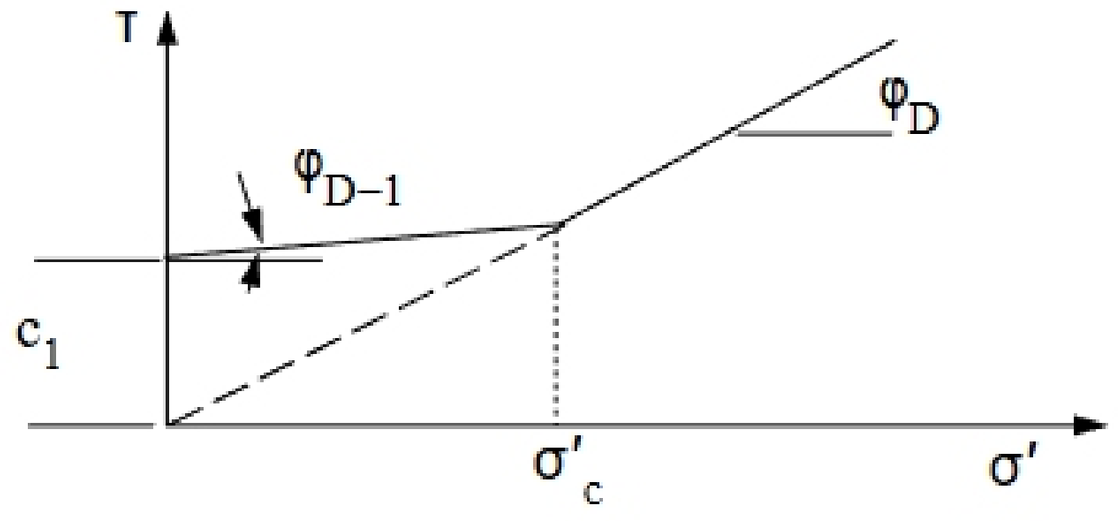
$$|\tau_f| = c_1 + \sigma'_n \tan(\varphi_{D-1})$$

- When the soil is normally consolidated: (or when $\sigma' = \sigma'_c$)

$$|\tau_f| = \sigma'_n \tan(\varphi_D)$$

- Typical values of φ_D for silty/clayey soils: $12^o \le \varphi_D \le 30^o$,

- $\varphi_D \approx 30^o$ for low plasticity soils (PI = 5−10);
- $\varphi_D \approx 12^o$ for high plasticity soils (PI = 50−100);
- $12^o \le \varphi_D \le 30^o$ for moderate plasticity soils ($10 \le PI \le 50$)



Example 24.1: