Period #5: Soil Consistency and Structure

A. Motivation:

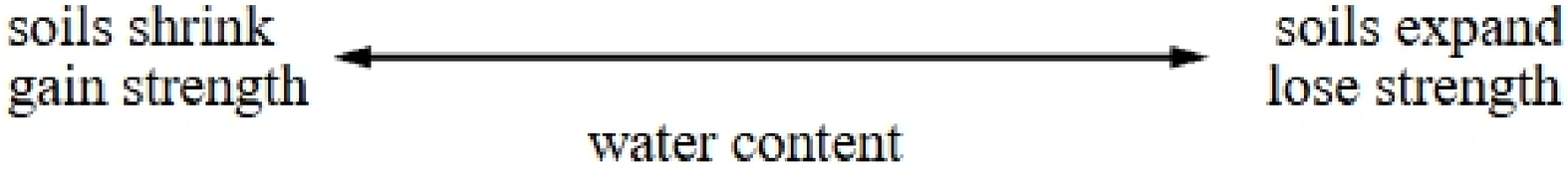
In geotechnical engineering, we need to determine the range of potential behaviors of a given soil type based on only *a few simple tests.* Typical concerns are the following:

i) soils might *shrink or expand excessively* in an uncontrolled manner after they've been placed in geotechnical structures (roadway subgrades, dams, levees, foundation materials, etc).
ii) soils might *lose their shear strength*, and ability to carry loads safely.

Tests used to detect potential problems for coarse–grained soils (gravels & sands) are different than those used to detect potential problems for fine–grained soils (silts & clays).

Coarse–Grained Soils:
water content is generally not a major factor
major factor leading to *shrinkage* is the *structure* of the soil skeleton.

Fine–Grained Soils:
water content is a *major factor*, especially when the soil contains so–called *active clays.*



B. Structure of Cohesionless, Granular, Coarse–Grained Soils

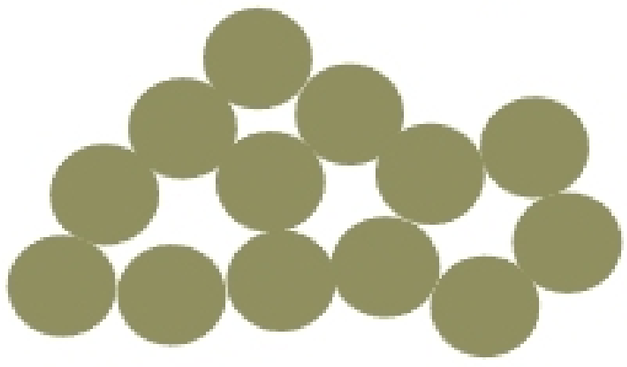
When speaking of cohesionless, granular soils, there are many possibilities:

Soils with angular grains:

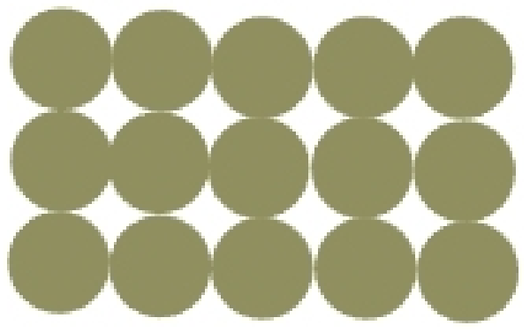
Loose, angular soil

Dense, angular soil

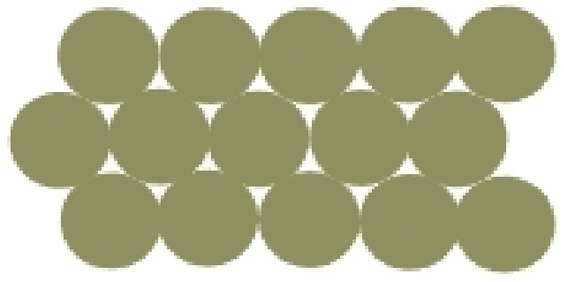
Soils with uniform, rounded grains:



Honey–combed soil
very loose ($e > 0.90$)

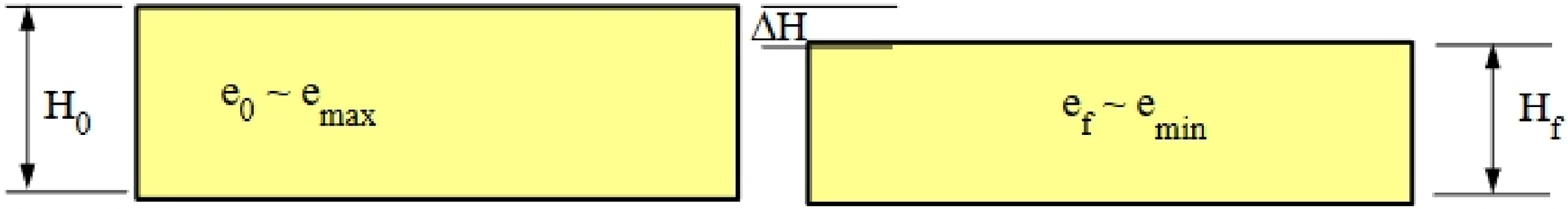


Square–packed grains
loose ($e = 0.90$)



Hexagonally packed grains
dense ($e = 0.35$)

- Soils in loose or honeycombed states are avoided, or compacted before being being built upon, since they are prone to densification when subjected to vibratory or shock loading (as from earthquakes or vibrating machinery).



$$\Delta H = H_0(e_0 - e_f) / (1 + e_0)$$

- The relative looseness of a soil in its natural, in–situ state is determined by measuring/ computing its relative density, D_r.
  [Recall that $D_r = (e_{max} - e) / (e_{max} - e_{min})$]

- The smaller D_r is for a given granular soil deposit, the more prone that soil deposit will be to densification and settlement.

- For uniform (poorly graded) spherical grained soils, the theoretical range of void ratios is $0.35 < e < 0.90$.