References:

- Das, B.M and Sobhan, K. (2016). *Principles of Geotechnical Engineering*, 8th edition (in this review note, the book is simply referred as Das & Sobhan 2016)
- Lecture notes on soil laboratory tests (in this review note three tests are referred to: Test 01, Test 02 and Test 05)

Chapter 2 in Das & Sobhan 2016

1. In geology, there are three types of rocks. What is the name of each rock type and how is each rock type formed?
2. Draw and explain about the rock cycle.
3. What is the origin of soils?
4. What is the weathering?
5. Soil types may be classified using two approaches: (1) by means of transportation of weathering products; (2) by grain sizes. By means of transportation of weathering products, what are possible soil types in practice? By means of grain sizes, what are possible soil types and what is the range of grain size of each soil type?

Chapter 3 in Das & Sobhan 2016

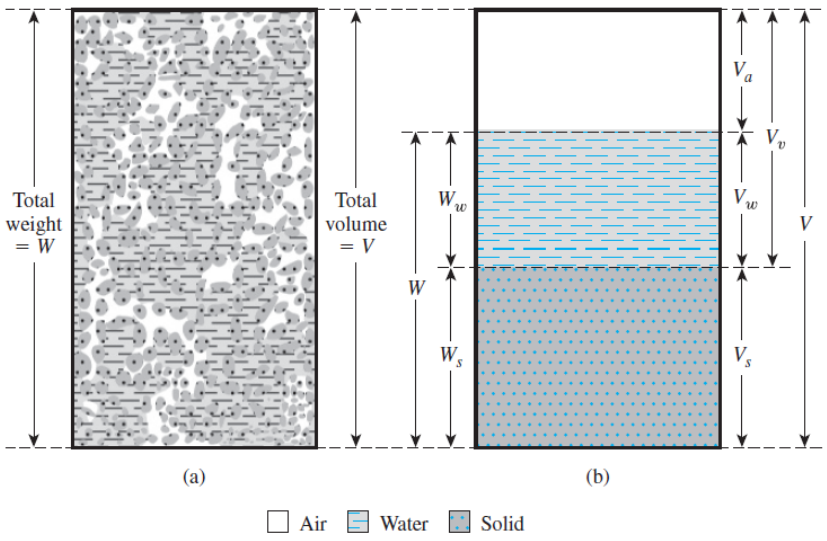

Fig. 3.1 (a) Natural soil element; (b) simplified 3-phase element (Das & Sobhan 2016)

6. Fig. 3.1 shows a soil element in natural state and its simplified element in 3 separated phases. From given parameters (e.g., *V, W,* V_s …), determine:

   - Definitions of *unit weight* (γ) and *density* (ρ)
   - Definitions of *dry unit weight* (γ_d) and *dry density* (ρ_d)
   - Definition of *water content* (*w*)
   - Definition of *void ratio* (*e*)
   - Definition of *porosity* (*n*)
   - Definition of *degree of saturation* (*S*)
   - Definition of *particle density* (ρ_s)
   - Definition of *specific gravity* (G_s)

7. Besides 10 basic physical indexes given in question 6 (for all soil types), additional parameters such as $\gamma_{d,min}$, $\gamma_{d,min}$, e_{max}, e_{min}, D_r (for coarse-grained soils only), *LL*, *PL*, *PI* (for fine-grained soils only) are also important to be reviewed. All the parameters and how to obtain them are briefly listed in Table 1.

   Table 1 Soil parameters and how to obtain them

Soil type	Parameter	How to obtain
All soil types	*Unit weight* (γ) *Density* (ρ) *Water content* (*w*)	Lab test: Water content & densities (Test 01)
	Particle density (ρ_s) *Specific gravity* (G_s)	Lab test: Specific gravity (Test 02)
	Dry unit weight (γ_d) *Dry density* (ρ_d) *Void ratio* (*e*) *Porosity* (*n*) *Degree of saturation* (*S*)	Calculated by relationships (equations)
Coarse-grained soils (Sand, gravel)	*Maximum dry unit weight*: $\gamma_{d,min}$, *Minimum dry unit weight*: $\gamma_{d,min}$ *Maximum void ratio* (e_{max}) *Minimum void ratio* (e_{min}) *Relative density* (D_r)	Lab tests: $\gamma_{d,min,}$ $\gamma_{d,min}$ Relationships: $e_{max} = f(\gamma_{d,min,} G_s, \gamma_w)$ $e_{min} = f(\gamma_{d,max,} G_s, \gamma_w)$ $D_r = f(e_{min}, , e_{max}, e)$
Fine-grained soils (silt, clay)	*Liquid limit (LL)* *Plastic limit (PL)* *Plasticity index (PI)*	Lab tests: Liquid and plastic limit tests (Test 05) *PI = LL-PL*

   Review/verify the relationships mentioned in the 3rd column of Table 1.

   Review/verify the relationships for γ, γ_d, and γ_{sat} given in Table 3.1 in Das & Sobhan (2016).

Chapter 4 in Das & Sobhan 2016

8. Depending on water content, a fine-grained (cohesive) soil may have four different states. What are these four states?
9. How does volume of the soil change with the change of water content?
10. What are definitions of *liquid limit* (*LL*), *plastic limit* (*PL*), and *shrinkage limit (SL)*?
11. How much is approximate undrained shear strength (s_u) of soil at the *LL*?
12. In practice, there are two common laboratory tests used to determine *LL*. What are the methods?
13. What is definition of *LL* from Casagrande's method?
14. What is definition of PL from rolling method?
15. What is definition of plasticity index (PI)?

Soil Laboratory Tests

16. In term of soil structure and cohesion, soil may have three different types: (1) fine-grained in cohesive state & easy to trim; (2) lumps in cohesive state but difficult to trim (broken when trimmed); (3) moist & crumbed into small pieces or separate particles. Depending soil type, we have different test methods to determine natural density (ρ) and water content (w) of the soil.
    - What are the method and its key steps used to determine ρ and w of soil type 1?
    - What are the method and its key steps used to determine ρ and w of soil type 2?
    - What are the method and its key steps used to determine ρ and w of soil type 3? ⇒ See principle and test procedures in Test 01: Water content and densities.
17. Review test procedures & how to determine soil parameters: ρ, ρ_d, γ, γ_d, and *w* from Test 01: Water content & densities.
18. Review test procedures & how to determine soil parameters: ρs, Gs, e, and from Test 02: Specific gravity
19. Review test procedures & how to determine liquid limit (LL) from Test 05: Liquid & plastic limits
20. Review test procedures & how to determine plastic limit (PL) from Test 05: Liquid & plastic limits

Worked examples

- Read and understand Examples 3.1 to 3.5 in Chapter 3 of Das & Sobhan (2016).
- Try to solve Problems 3.4 to 3.19 at the end of Chapter 3 in Das & Sobhan (2016).
- Try to solve Problems 4.1 to 4.3 at the end of Chapter 4 in Das & Sobhan (2016).

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