มหาวิทยาลัยสงขลานครินทร์
คณะวิศวกรรมศาสตร์

การสอบกลางภาค ประจำภาคการศึกษาที่ 1 ปีการศึกษา 2554

สอบวันที่ 2 สิงหาคม 2554 เวลา 13:30-16:30 น

วิชา 220-526 Unsaturated Soil Mechanics ห้องสอบ A401

Instruction:

1. There are 5 problems with total of 150 points, students are asked to do all of them.
2. This is a closed book exam.
3. All types of calculators are allowed.
4. Answers can be written in Thai.

Name.....Code.....

Question	Full score	Score received
1	30	
2	36	
3	28	
4	36	
5	20	
Total	150	

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Instructor

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I Introduction to Unsaturated soil mechanics (30 points)

1.1 Explain contractile skin and 4-phase diagram (4 points)

1.2 Explain the difference between vadose zone and unsurated zone. (4 points)

1.3 Explain changes in soil properties from saturated to unsaturated soils. (4 points)

1.4 Does increase in pore-air pressure due to compaction in dam constructiong result in changing of stability of the dam? (4 points)

1.5 The moist unit weight of a soil is 16.5 kN/m^3, given that gravimatric water content (w) = 15%, and G_s = 2.7. Determine volumetric water content (θ) and saturated volumetric water content (θ_s) of the soil. (14 points)

2 Stress-state variables (36 points)

2.1 Explain and define "Stress-state variables" involved in unsaturated soil mechanics. (4 points)

2.2 Explain the difference in the effective stress between saturated and unsaturated soils. (4 points)

2.3 What is dual stress-state variable? Also, show that list of possible dual stress-state variables. (4 points)

2.4 Data obtained from a null-test on an unsaturated soil indicated that the total stress = 410.5 kPa, pore-air pressure = 338.7 kPa, and pore-water pressure = 160.0 kPa. Are these the correct pressures to use? Given that the degree of saturation and χ are 0.6. What is the effective stess of the soil being tested? If the total stress increases 40 kPa, what would be the pore-air and pore-water pressures? (12 points)

2.5 A unsaturated sandy soil having moist unit weight of 16 kN/m^3, porosity of 46%, and χ of 0.6. The depth of vadose zone is about 10 meters. At hydrostatic equilibrium, calculate and plot total stress, effective stress and pore water pressure profiles from ground surface to water table. (12 points)

3. Sunction measurement. (28 points)

3.1 Briefly explain: total, matric, and osmotic suctions. (4 points)

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3.2 Explain thermodynamics relationship between soil suction and pore-air vapor pressure. (4 points)

3.3 Explain the concept of psychrometer in measuring soil suction. (4 points)

3.4 Explain how axis translation technique can be used for measuring suctions. (4 points)

3.5 Explain how tensiometer can be used for measuring matric suction. Also, describe the limitation of the tensiometer. (4 points)

3.6 Calculate a capillary height (h_c) if the measured radius of curvature of the meniscus (R_s) is 1 mm. (8 points)

4. Soil-water characteristic curves (36 points).

4.1 Sketch SWCC of a soil and explain all parameters involved. (4 points)

4.2 Sketch the wetting and drying SWCCs and explain the cause of hysteresis. (4 points)

4.3 Sketch the SWCCs of CL and CH soils and explain the difference between them. (4 points)

4.4 Sketch SWCCs of a CH soil compacted at wet and dry of optimum water content and explain the difference between them. (4 points)

4.5 SWCC data are shown in the table below. Given that θ_r = 0.09, θ_s = 0.38, n = 1.3, determine α (1/cm) of van Genuchten equation by minimizing MSE. Also give your best estimate of the type of this soil. (20 points)

ψ (kPa)	θ
1.0	0.360
6.0	0.320
12.0	0.285
50.0	0.211
100.0	0.188
240.0	0.160
430.0	0.160
640.0	0.155

van Genuchten equation:

$$\Theta = \frac{\theta - \theta_r}{\theta_s - \theta_r} = \left[\frac{1}{1+(\alpha\psi)^n}\right]^m$$

5. Flow of water in unsaturated soil. Derive Richard's unsaturated flow equation. (20 points)