

# มหาวิทยาลัยสงขลานครินทร์

## คณะวิศวกรรมศาสตร์

การสอบปลายภาค ประจำภาคการศึกษาที่ 2  
 สอบวันที่ 18 กุมภาพันธ์ 2551  
 วิชา 220-524 Waste Geotechnics

ปีการศึกษา 2550  
 เวลา 09:00-12:00 น  
 ห้องสอบ R300

ชื่อ..... รหัส.....

**คำชี้แจง**

1. ข้อสอบมี 5 ข้อ 100 คะแนน ให้ทำทุกข้อ
2. อนุญาตให้นักศึกษานำเครื่องคิดเลขเข้าห้องสอบได้
3. **ไม่**อนุญาตให้นักศึกษานำเอกสารใดๆ เข้าห้องสอบ ยกเว้น Note ในกระดาษ A4

ออกข้อสอบโดย ผศ. ดร. ธนิต เฉลิมยานนท์

**Problem 1: Compaction Design (15 points)**

Hydraulic conductivity tests were conducted on specimens of a moderate plastic clay prepared with reduced (RP), standard (SP), and modified (MP) proctor efforts. Results of the tests are summarized in the following table. Develop an acceptable zone for compaction control that will achieve hydraulic conductivity less than  $10^{-7}$  cm/s. Note that to obtain the requirement of shear strength and desiccation, the water content should be greater than 8% and following equation

$$\gamma_d > 0.05w + 19.0$$

where  $\gamma_d$  is in  $\text{kN/m}^3$  and w is in percent.

Table 1. Compaction and hydraulic conductivity test results

W(%)	$\gamma_d$ ( $\text{kN/m}^3$ )	CE	K (cm/s)	W(%)	$\gamma_d$ ( $\text{kN/m}^3$ )	CE	K (cm/s)
8.0	16.9	RP	2.1e-6	11.3	20.0	SP	3.2e-8
10.1	18.0	RP	7.5e-7	15.0	18.6	SP	9.4e-8
13.3	18.6	RP	9.8e-8	3.6	19.7	MP	4.2e-7
14.5	18.5	RP	8.1e-8	6.0	20.6	MP	9.4e-8
16.5	17.7	RP	2.3e-7	9.0	21.2	MP	3.2e-8
17.8	17.2	RP	5.3e-7	11.2	20.8	MP	1.1e-8
5.4	19.0	SP	5.7e-7	12.6	20.1	MP	1.8e-8
8.6	20.1	SP	7.8e-8				

**Problem 2: Chemical compatibility Test (15 points)**

Chemical compatibility tests were conducted on five candidate clays being considered for use as liner in a hazardous waste landfill. The leachate that will be generated from the hazardous waste contains mainly calcium and also contains lead, zinc, and cadmium. The laboratory conducting the test using water as influent until steady hydraulic conductivity measurements were obtained. Then the water was replaced by the hazardous waste leachate, and the tests were continued for 3 weeks, at which the hydraulic conductivities were steady. Results of the test indicated that 4 of 5 candidate clays have hydraulic conductivity less than  $10^{-8}$  cm/s when exposed to the leachate. You are asked to evaluate this test results. What is your comment to this test result regarding the chemical compatibility of the candidate clays?

**Problem 3: Two-Stage Borehole Test (25 points)**

Filed hydraulic conductivity measurements were made on a clay liner with a two-stage borehole permeameter. The casing had an inside diameter of 10 cm and the standpipe had an inside diameter of 1.0 m. The zero reading on the standpipe was located 91.5 cm above the base of the borehole. The borehole extension was 15 cm long. Data collected from Stages 1 and 2 are shown in Table 2. Determine the vertical and horizontal hydraulic conductivities.

Table 2. Two-Stage Borehole Test Results

Stage 1			Stage 2		
Date	Time	Reading (cm)	Date	Time	Reading (cm)
20-Apr	14:35	92.0	30-Apr	13:10	92.0
21-Apr	8:50	58.0	30-Apr	17:43	83.3
21-Apr	9:00	92.0	1-May	7:37	60.5
21-Apr	15:50	85.1	1-May	11:06	55.1
22-Apr	7:56	72.4	1-May	14:40	46.9
22-Apr	8:25	92.0	1-May	17:06	92.0
23-Apr	7:15	76.7	2-May	12:17	60.3
23-Apr	17:52	70.7	2-May	12:17	92.0
24-Apr	8:40	61.4	4-May	7:21	4.3
24-Apr	16:20	58.9	4-May	7:21	92.0
25-Apr	11:36	48.7	4-May	11:35	83.9
27-Apr	7:53	27.9	4-May	14:32	79.8
27-Apr	8:18	92.0			
28-Apr	9:11	78.3			
28-Apr	16:00	74.5			
29-Apr	7:45	67.3			

**Problem 4: Leachate Collection System (25 points)**

You are asked to design a leachate collection system for the new Hat Yai Municipal landfill. This landfill will have dimension of 200-m long, 200-m wide and 15-m deep. Note that annual precipitation of Hat Yai area is 2000 mm/yr and unit weight of waste is  $12 \text{ kN/m}^3$ . Please show your calculation and provide all parameters used.

**Problem 5: Veneer Stability (20 points)**

A liner system consists of (from top to bottom): sand (LCS), geotextile, geonet, geomembrane, and compacted clay liner (CCL). The tensile strength values of the geotextile, geonet, geomembrane are 75, 50, and 50 kN/m, respectively. The interface and internal friction angles are as follows: sand-GT =  $20^\circ$ , GT-GN =  $23^\circ$ , GN-GM =  $10^\circ$ , GM-CCL =  $25^\circ$ , sand (internal) =  $30^\circ$  and undrained shear strength of CL = 25 kPa. The slope is  $18^\circ$  and the length of the slope is 50 m. The unit weight of sand is  $18 \text{ kN/m}^3$ . Determine the tension in each geosynthetic layer. Do these materials have adequate tensile capacity? Can these layers be adequately anchored with an anchor trench (0.6 m wide and 1.25 m deep) and a run-out length of 2.0 m. Note that the trench is backfilled with sand.

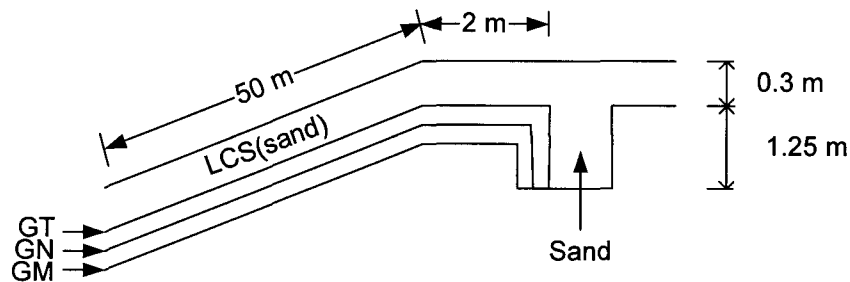


Fig. 1. Cross section of the landfill liner