

**UNIVERSITY OF SOUTH AUSTRALIA**  
**School of Natural and Built Environments**  
**FIRST SEMESTER EXAMINATIONS, 2006**

**Introduction to Civil and Mining Engineering CIVE 2006**  
**Course Coordinator: Dr. Don Cameron**

<b><u>Name and Number of Candidate</u></b>	<b>Program:</b> <b>Reading time: 10 minutes</b> <b>Exam Duration: 2.5 hours</b>
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**Instructions:** Generally the questions require you to place a cross against the correct answer in the box provided. One line answers may also be required. **You will require an exam booklet to answer the last question on quarry practices.**

Marks are indicated for each section (total = 100%).

Some equations and notations for the Soil Engineering component follow

**Void ratio** 
$$e = \frac{V_v}{V_s}$$

**Degree of saturation** 
$$S = \frac{V_w}{V_v}$$

**Dry density** 
$$\rho_d = \frac{M_s}{V} = \frac{\rho_s}{1+e} = \frac{\rho}{(1+w)}$$

**Moisture content** 
$$w = \frac{M_w}{M_s} \quad \text{Or} \quad w\% = 100 \frac{M_w}{M_s}$$

**Darcy's Law** 
$$q = kiA \quad i_{crit} = \frac{\gamma'}{\gamma_w}$$

**Flownet** 
$$q = k \left( \frac{N_f}{N_d} \right) \Delta h$$

**Compaction** 
$$I_D = \frac{(e_{max} - e)}{(e_{max} - e_{min})}$$

Symbol	Used for	Common Units	Description/comment
e	Void ratio	none	Ratio of the volume of the voids to the volume of solids
w	Moisture content, water content	%	Mass of water/mass of solids
n	Porosity	none	Ratio of the volume of the voids to the total volume

Continued over the page...

Symbol	Used for	Common Units	Description/comment
$\rho$ - rho	Density	$\text{g/cm}^3$ or $\text{t/m}^3$	Mass/volume
$\rho_d$	Dry density	$\text{g/cm}^3$ or $\text{t/m}^3$	Mass of solids/volume
$\rho_s$	Density of soil solids	$\text{g/cm}^3$ or $\text{t/m}^3$	Usually varies from 2.6 - 2.7
$\rho_w$	Density of water	$\text{g/cm}^3$ or $\text{t/m}^3$	= 1
$\gamma$ - gamma	Total or bulk unit weight	$\text{kN/m}^3$	= $\rho g$
$g$	Acceleration due to gravity	$\text{m/sec}^2$	9.81
$\gamma'$	Effective unit weight	$\text{kN/m}^3$	= $\gamma - \gamma_w$
$\gamma_w$	Unit weight of water	$\text{kN/m}^3$	
$h$	Head of water	m or cm	
$h_e$	Elevation head	m or cm	
$h_p$	Pressure head	m or cm	
$i$	Hydraulic gradient	none	Loss in total head ( $\Delta h$ ) between two points over length of flow
$u$	Pore water pressure	kPa	= $\gamma_w z_w$ below a WT
$k$	Coefficient of hydraulic conductivity, or permeability	$\text{m/sec}$ usually	
WT	Permanent water table		
$q$	Rate of flow	$\text{m}^3/\text{sec}$	
OMC	Optimum moisture content	%	To achieve max dry density for a given compaction energy
$R_D$	Dry density ratio	none	Ratio of achieved to maximum possible dry densities for a soil, for a given compaction energy
$I_D$	Density index	%	Clean granular soils only

**PART A - SOIL ENGINEERING: QUESTIONS**

**42%**

*All questions are of equal value unless otherwise stated e.g. (1.5)*

1. One of the field tests for the Unified Soil Classification System (USCS) is the dilatancy test, which is performed on finer sand, silt and clay fractions of the soil. A pat of soil is saturated in the palm of the hand, wetted and tapped until water is seen on the soil surface. What is dilatancy?

- The contraction of the soil as its is stretched or sheared
- The expansion of the soil as its is stretched or sheared
- The loss of water content as the soil is sheared

2. How are **fine-grained** soils classified by the USCS?

- Colour and structure
- Liquid limit and plastic index
- Particle size distribution and particle sizes
- Moisture content and density

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3. Sand possesses relatively high strength when moist (but not saturated) and when it is subjected to little stress because:

- Sand particles are extremely strong crystals of quartz  
 Sand particles are generally rounded  
 The pore water is held in tension, creating “suction”  
 Water lubricates soil

4. The amount of clay particles in a soil is determined by which of the following laboratory tests?

- Sedimentation test  
 Linear shrinkage test  
 Plastic limit and liquid limit tests  
 Free swell test

5. The liquid limit test determines primarily, which one of the following properties?

- Soil strength  
 Moisture content between the plastic and limit states of a fine soil  
 Plasticity of the soil  
 The ability of the soil to flow

6. The following clay minerals may be rated in terms of the plasticity they impart to soil. Rate them in the order of plasticity, assigning 1 to the highest plasticity and 3 to the lowest. (1.5)

- Illite  
 Montmorillonite  
 Kaolinite

7. Compaction is best described by:

- Squeezing out of water from the soil  
 Removal of any air in the soil system  
 Gradual removal of most of the air in the soil’s void space  
 Physical crushing of soil particles

8. Which type of earthworks requires soil to be compacted slightly wet of OMC?

- Road embankments  
 Earth dams  
 Housing subdivisions

9. The compaction curve for a soil has been determined in the laboratory, giving an OMC of 14% and a maximum dry density of  $1.70 \text{ t/m}^3$ . If a minimum dry density ratio or  $R_D$  of 98% has been specified, what is the bulk density that meets this requirement, if the moisture content of the soil is 15% on the site? (1.5)

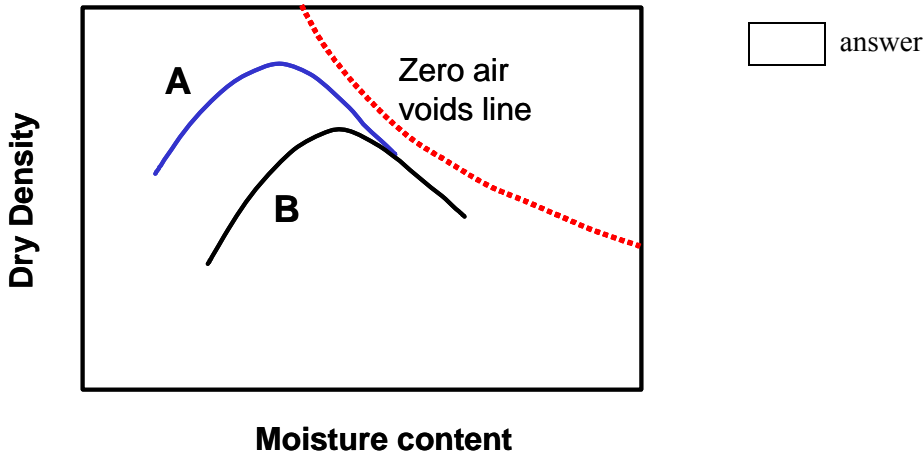
- $1.92 \text{ t/m}^3$   
  $1.94 \text{ t/m}^3$   
  $1.95 \text{ t/m}^3$

**NAME:**

**ID NO.:**

10. Why does clean granular soil not have a distinctive compaction curve? Explain briefly in the space provided. (1.5)


11. A soil has had compaction curves generated for both Standard and Modified compactive effort as indicated in the following diagram. Which curve, A or B, corresponds to Modified compaction?



12. A soil profile, which consists of a soil with a total unit weight of 18 kN/m<sup>3</sup> to a depth of three metres, is underlain by a thick layer of a different soil, which has a total unit weight of 20 kN/m<sup>3</sup>. The total vertical stress at a depth of six metres below ground level is:

- 108 kPa
- 114 kPa
- 120 kPa

13. If a water table exists at a depth of 2 m below ground level in the soil profile in the previous question, what is the effective vertical stress at 6 m depth? Take the unit weight of water to be ≈ 10 kN/m<sup>3</sup>.

- 68 kPa
- 74 kPa
- 80 kPa
- 154 kPa

14 and 15. The dry density of a compacted soil is to be determined given the following information;  
 Volume of compaction mould = 1000 cm<sup>3</sup>

Moisture content determination

- Mass of container, 2890 g
- Mass of container and wet soil, 4870 g
- Mass of container and dry soil 4673 g

14. What is the moisture content of the soil?

- 9.9 %
- 4.2 %
- 11.0 %

15. What is the dry density of the soil?

- 1.783 t/m<sup>3</sup>
- 1.980 t/m<sup>3</sup>
- 1.802 t/m<sup>3</sup>

16 to 19. A soil has a moisture content of 10%. If the total or bulk density of the soil is 1.95 t/m<sup>3</sup> and the soil particle density,  $\rho_s$ , is 2.7 t/m<sup>3</sup>, find from first principles by assuming a cubic meter (volume) of soil;

16. Mass of soil solids $M_s$ (t)	
17. Mass of water $M_w$ (t)	
18. Volume of voids $V_v$ (m <sup>3</sup> )	
19. Void ratio, e	

Show working:

20 to 25. In two dimensional seepage analysis, a flow net is constructed. The rate of flow through the flownet may be calculated by Darcy’s law, which may be adapted to the flownet in the form,

$$q = k \left( \frac{N_f}{N_d} \right) \Delta h$$

Answer the following questions related to the flownet for the masonry dam with 30 m

deep cut-off wall as shown in Figure 1. The dam retains water to a height of 50 m and the pondage on the downstream side has a height of 5 m. The soil has a permeability,  $k$ , of  $10^{-7}$  m/sec.

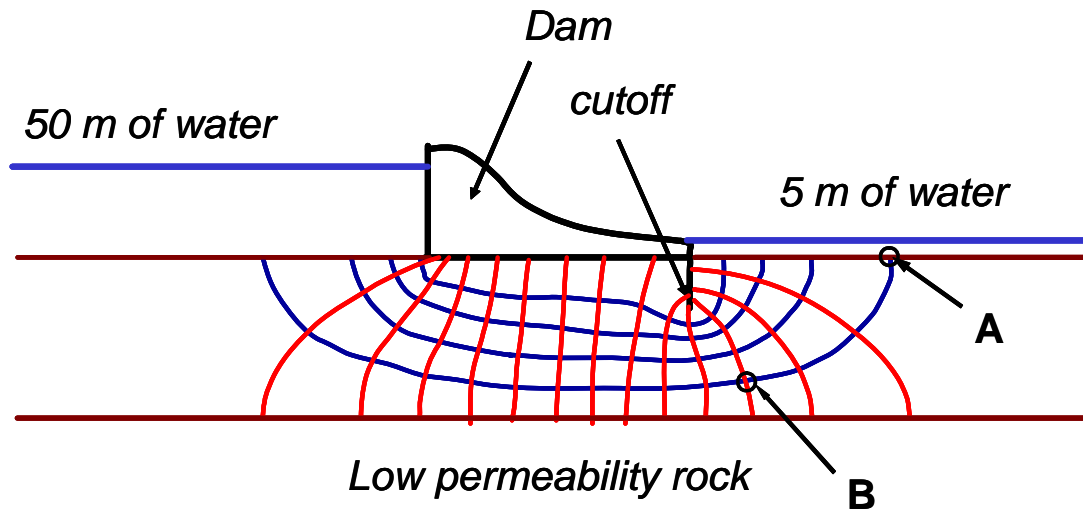
20. $\Delta h$ (m)	
21. $N_f$	
22. $N_d$	
23. $q$ (m <sup>3</sup> /day per km length of dam)	
Note: 1 day = 86,400 secs/day	

24. Estimate the loss of total head between points B and A in the soil foundation. Which answer is correct?

- 5.0 m
- 9.6 m
- 4.6 m

25. What answer is closest to your estimate of the average hydraulic gradient in the last 3 “squares” to the right of the cut-off?

- 0.1
- 0.2
- 0.3
- 0.5



**Figure 1: Flownet**

26. What is the purpose of the vertical cut-off located below the downstream end of the dam?

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27. What is the best laboratory method for determining the hydraulic conductivity (or saturated permeability) of a clayey silt?

- |  |                                    |
|--|------------------------------------|
|  | The constant head permeameter test |
|  | The free swell test                |
|  | The falling head permeameter test  |

**PART B: CONCRETE TECHNOLOGY****40%***Circle the most appropriate answer – all questions are of equal value*

Q1. Name the main raw materials used to make Portland Cement clinker.

- A: Limestone, clay & ironstone
- B: Gypsum, fly ash & limestone
- C: Bauxite, & limestone

Q2. How much Fly ash is normally blended with cement, to produce Type GB cement in South Australia.

- A: 15%
- B: 20%
- C: 25%
- D: 30%

Q3. The name Type HES cement means

- A: Quick setting cement
- B: High early strength of concrete
- C: Early heat of hydration

Q4. The Fly ash used for blended cement is obtained from

- A: By products of the silicon manufacture industry
- B: Waste from steel manufacturing
- C: Waste from coal fired power stations

Q5. What is the most desirable shape for coarse aggregate?

- A: Angular
- B: Elongated
- C: Flaky

Q6. The specific gravity of normal aggregates is

- A:  $\leq 2100 \text{ kg/m}^3$
- B: between  $2500 \text{ \& } 2900 \text{ kg/m}^3$
- C:  $\geq 3500 \text{ kg/m}^3$

Q7. What water would you choose for concrete?

- A: Drinkable (Potable) water
- B: Bore water
- C: Sea water

Q8. Why would you use an admixture in concrete?

- A: To alter or improve the fresh properties
- B: To correct a bad mix design
- C: To reduce the stone content of the mix

Q9. Calcium chloride can be used in concrete where

- A: Low shrinkage is a requirement
- B: Resistance to sulphates are necessary
- C: There is no reinforcement

Q10. Which water/cement (w/c) ratio will produce the highest 28-day compressive strength?

- A: 0.61
- B: 0.43
- C: 0.55

Q11. If the water demand of two different sands are 182 ℓ and 210 ℓ respectively, how much more cement will be needed if the w/c ratio is specified as 0.56

- A: 56
- B: 15
- C: 50

Q12. Which is the best definition of curing

- A: Curing prevents the loss of moisture from the concrete thus allowing the full hydration of the cement
- B: Curing allows the concrete to dry out rapidly thus ensuring early strength
- C: Curing prevents hydration thereby improving the strength of the concrete

Q13. Which method of curing is the least desirable?

- A: Covering with plastic sheeting
- B: Using a curing membrane
- C: Spraying intermittently with water

Q14. Formwork can contribute significantly to the overall cost of a project, suggest how much

- A: 20 – 30 %
- B: 35 – 60 %
- C: 70 – 80%

Q15. Honeycombing & blowholes can be prevented by

- A: Dry concrete
- B: Better curing
- C: Good compaction

Q16. Name the type of joint needed around columns

- A: Saw cut joints
- B: Keyed joints
- C: Isolation joints

Q20. At least how deep should the saw cut be made to ensure cracking through the concrete?

- A: 20% of the depth
- B: 25% of the depth
- C: 50% of the depth

Q21. The joint spacing on a slab should not be greater than what factor of the thickness

- A: 30 x thickness
- B: 10 x thickness
- C: 15 x thickness

Q22. The type of finish where the aggregate is visible is called

- A: Off-shutter finish
- B: Exposed aggregate finish
- C: Fair face finish

Q23. Water stops are usually used in what type of structure

- A: Long slender columns
- B: Water retaining structures
- C: Retaining walls

Q24. What is a very important aspect of a doweled joint?

- A: The dowel should be well anchored on both ends
- B: They dowel must be square and level in both the horizontal and vertical planes
- C: The dowel must not be anchored at either end

Q25. Creep can be reduced by

- A: Reducing the concrete strength
- B: Increasing the volume of cement paste
- C: Using larger aggregates

Q26. Durability of concrete can be improved by

- A: Reducing the concrete strength
- B: Increasing the cover to reinforcement
- C: Disregarding any curing

Q27. Which of the following will assist in reducing the corrosion of the reinforcement

- A: Increasing the cover to the reinforcement
- B: Using calcium chloride accelerators
- C: Reducing the curing time

Q30. How many times is the layer in the slump test tamped?

- A: 20
- B: 30
- C: 25

Q31. How many layers are required for the slump test

- A: 3
- B: 4
- C: 2

Q32. How many layer are required to fill the 100 x 200 mm concrete cylinder mould

- A: 3
- B: 4
- C: 2

Q33. How many times is each layer of the concrete cylinder mould tamped?

- A: 25
- B: 20
- C: 30

Q34. Plastic shrinkage cracks are primarily caused by

- A: Rapid early drying
- B: Excessive bleeding
- C: Excessive heat generation

Q35. The term gunite generally means

- A: Aggregate greater than 20 mm
- B: Sand smaller than 1 mm
- C: Aggregate less than 5 mm

Q36. The term shotcrete generally means

- A: Aggregate greater than 20 mm
- B: Aggregate less than 5 mm
- C: Sand smaller than 1 mm

Q37. For wet sprayed concrete the water is added at what stage

- A: At the nozzle
- B: At the mixer
- C: In both places

- Q38. For dry spraying the liquid accelerator is added at what stage  
A: At the nozzle  
B: At the mixer  
C It is already incorporated in the materials
- Q39. What test method was used to determine the tensile strength of the concrete  
A: Brazil Splitting test  
B: Creep Test  
C: Vebe Consistometer Test
- Q40. What was the distance between the rollers in the Flexural Beam test  
A: 150 mm  
B: 100 mm  
C: 300 mm

## **PART C: QUARRY PRACTICES**

**18%**

### **QUESTION 1C**

**You will require an exam booklet to answer this question. Please make sure you fill out the front of the booklet.**

In order to run a quarry successfully to supply the civil engineering industry with crushed rock and aggregate for construction, the quarry has to be established, the rock quality has to be determined and methods of accessing and producing the product have to be chosen. Rock must be moved for processing.

Discuss the items above, indicating generally what is needed and what tools are available to assist in achieving this goal. Suggest how the soil and rock found on site might affect your decisions.