OCD052

UNIVERSITY OF BOLTON

WESTERN INTERNATIONAL COLLEGE FZE

BEng (Hons) CIVIL ENGINEERING

SEMESTER ONE EXAMINATION 2018/2019

GROUND AND WATER STUDIES 1

MODULE NO: CIE4009

Date: Thursday 17th January 2019 Time: 1.00pm - 4.00pm

INSTRUCTIONS TO CANDIDATES:

There are FIVE questions on this paper.

Answer any FOUR questions.

Answer SECTION A and SECTION B on separate answer books

All questions carry equal marks.

Marks for parts of questions are shown in brackets.

This examination paper carries a total of 100 marks.

Formula sheet/supplementary information is provided at the end of each section.

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SECTION A

Question 1

(a) Explain the Continuity equation and Bernoulli's Equation used in the analysis of fluid flow. Use suitable diagram.

(8 marks)

(b) A canal has a bottom width of 3m and sides with a slope of 1 vertical to 2 horizontal and a bed slope of 1 in 5000. Using the Manning formula with n = 0.019, calculate the discharge in m^3/s when the depth of flow is 1.3m.

(9 marks)

(c) Water is transferred from reservoir to a tank through a pipeline 225 mm in diameter. The pipe is 14 km long and the tanks are having a height difference of 50 m. Determine the flowrate between the reservoirs if the pipe material is having pipe wall roughness ks = 0.03mm.
HRS tables can be found on Page 4.

(8 marks)

Total 25 marks

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Question 2

(a) A vertical bulkhead 3m wide divides a storage tank. On one side of the bulkhead petrol with density 780 kg/m^3 is stored to a depth of 2.0 m and on the other side water is stored to a depth of 1.1 m. Determine the resultant force on the bulkhead and the position where it acts

(10 marks)

(b) Water flows from a storage tank along a 250mm diameter pipe, 50m long at a rate of 0.1m^3/s. The pipe includes two 90° bends (k_L = 0.7), two 45° bends (k_L = 0.2), a fully open gate valve (k_L = 0.25) and a partially shut valve (k_L = 6). If the pipe entrance is sharp and the flow discharges to atmosphere at the end of the pipe, calculate the necessary difference in level between the tank water level and the outlet. Take the pipe friction factor, λ = 0.04.

(15 marks)

Total 25 marks

Supplementary information for SECTION A is provided on Pages 14

End of SECTION A

Turn the page for SECTION B

Please turn the page

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SECTION B

Question 3

(a) What is an Alluvial terrace? How do these deposits form?

(3 marks)

(b) Properly collecting soil samples is the most important step in any nutrient/soil amendment management program. Briefly explain the two categories of soil samples and its application.

(3 marks)

(c) The results of a sieve analysis on a soil sample of initial mass 950gm are given below in Table Q3(a) :

Table Q3 (a)

Sieve size (mm)	Mass retained (g)
10.0	0
6.3	19
5.0	36
3.35	42
2.0	82
1.18	152
0.60	154
0.425	144
0.30	116
0.212	58
0.150	39
0.063	30
Tray	78

(i) Determine cumulative percentage passing and plot the particle size distribution (PSD) on the chart provided in **Figure Q3a on page 6.**

(9 marks)

Question 3 continued over the page

Please turn the page

Question 3 continued

(ii) Using the PSD curve, determine the percentage of gravel, sand and silt in the given soil. Also provide a soil classification NAME and symbol.

(3 marks)

(d) In its natural condition a soil sample has a mass of 2290g and a volume of 1.15×10^{-3} m^3. After being completely dried in an oven the mass of the sample is 2035g. The value for Gs for the soil is 2.68. Determine the :

(i) Bulk Density , kg/m^3
(ii) Dry unit weight , kN/m^3
(iii) Water content (%)
(iv) Void Ratio
(v) Porosity
(vi) Degree of saturation %
(vii) Air content

(7 marks)

Total 25 marks

Question 3 continued over the page

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Question 3 continued

PARTICLE SIZE DISTRIBUTION CHART

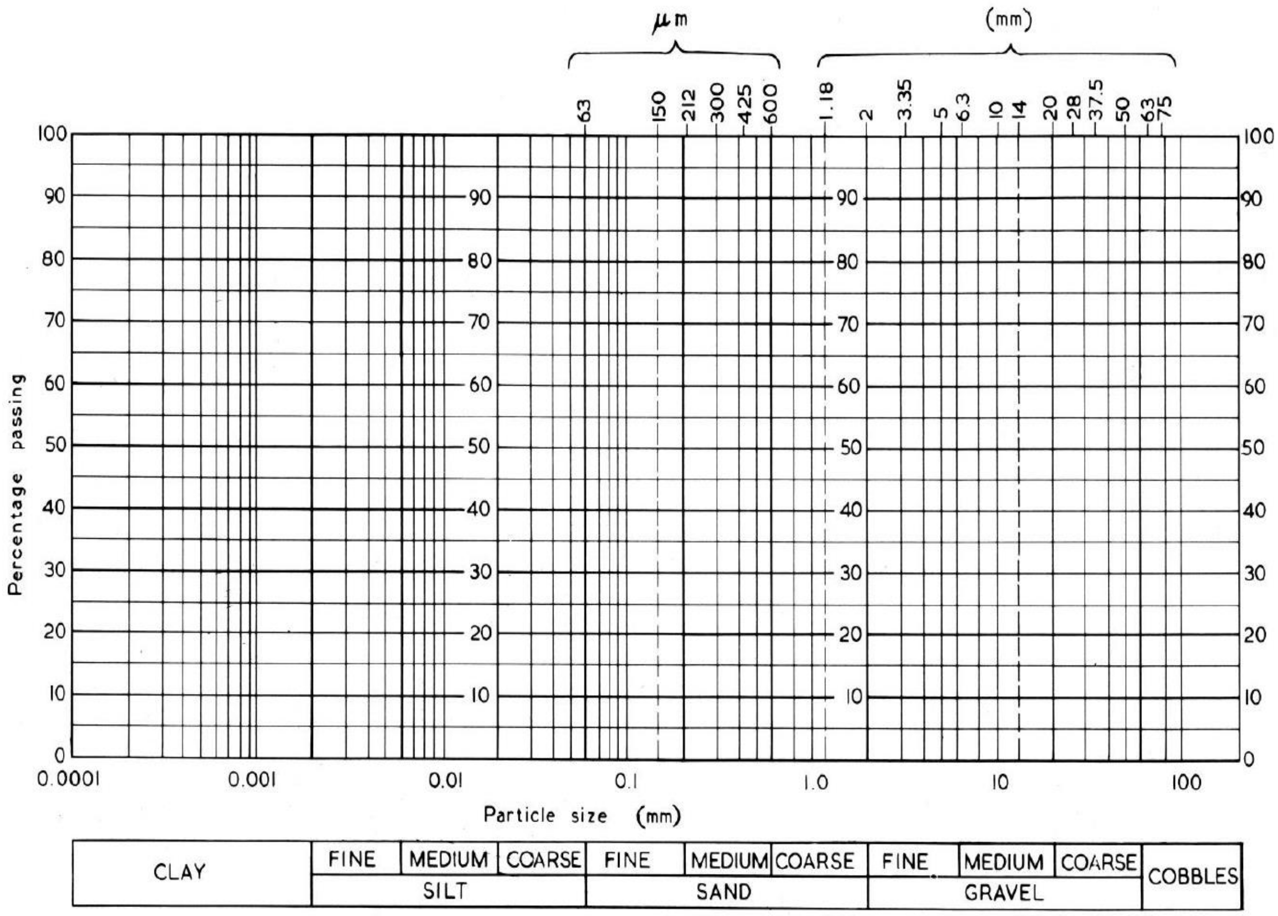

FIGURE Q3a

Candidate Number……………………….

PLEASE ATTACH THIS SHEET TO YOUR ANSWER BOOKLET

Question 4

(a) Briefly outline the stages and range of techniques commonly used in site investigation. Ensure that your answer covers a comprehensive range of techniques both in the office before site works and also a comprehensive range of techniques 'in the field'.

(7 marks)

(b) Sketch a typical 'dry density' versus 'moisture content' curve as produced from a 2.5kg rammer compaction test with a clay soil. Show the expected shape of the curve from a 4.5kg rammer on the same sketch. Explain why the curves have their characteristic shapes.

Also sketch the zero air voids line in the same curve and explain why it does not coincide with the Line of optimum.

(6 marks)

(c) The results of a classification test conducted on a soil sample are shown below;

Table Q4 (a) Plastic Limit Test

	Test 1	Test 2
Mass of empty tin (g)	16.60	17.82
Mass of tin + wet soil (g)	42.08	44.83
Mass of tin + oven dried soil (g)	37.79	40.40

Question 4 continued over the page

Please turn the page

Question 4 continued

Table Q4 (b) Liquid Limit Test

Cone penetration (mm)	15.50	18.00	19.4	22.2	24.9
Moisture content (%)	39.3	40.8	42.1	44.6	45.6

(i) Using the data above and **Figure Q4a**, as appropriate, determine the 'Index Properties' for this soil.

(8 marks)

(ii) Define what the 'Index Properties' are for fine-grained soils with the help of a graph.

(2 marks)

(iii) Provide a soil classification name and symbol for this soil using **Figure Q4b**

(2 marks)

Total 25 marks

Question 4 continued over the page

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Question 4 continued

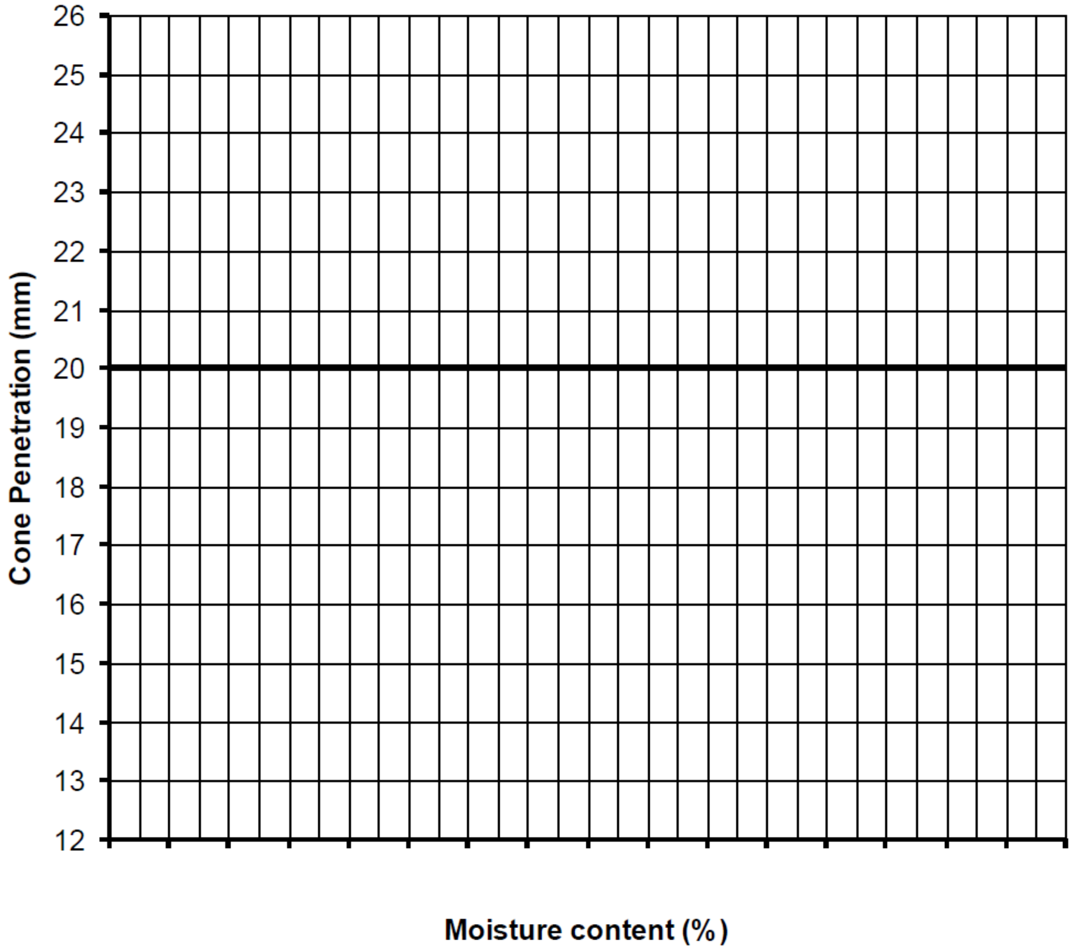

FIGURE Q4a.

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Question 4 continued over the page

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Question 4 continued

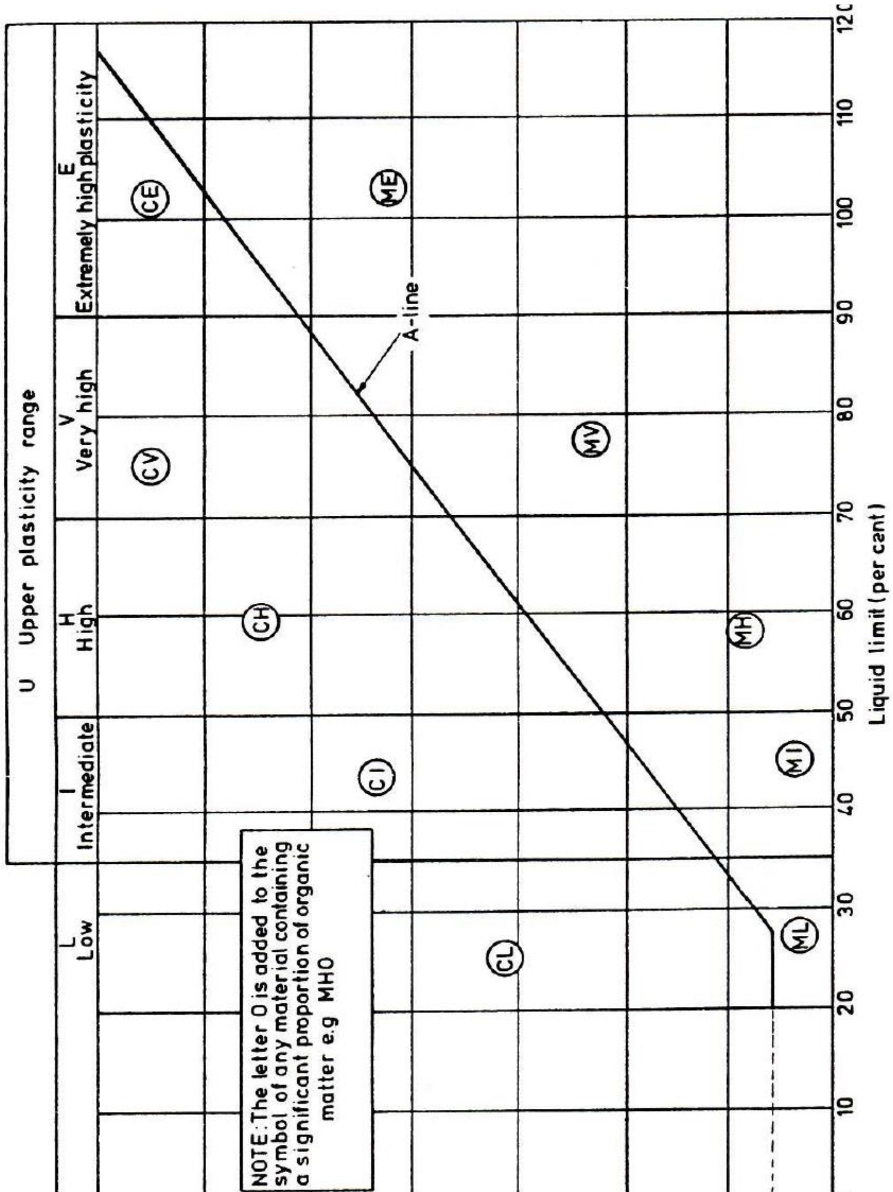

FIGURE Q4b.

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Question 5

(a) Describe how Standard Penetration Test results predict the geotechnical engineering properties when carried out in firm to stiff sandy CLAY and also in a medium dense coarse GRAVEL. Ensure that your answer states how the test results from an SPT test are written down and interpreted.

(5 marks)

(b) Sketch a "Soil Model Diagram" and show every term on your soil model diagram with the corresponding 'algebraic term' for the respective mass and volume of the solids, water and air.

(NOTE: Do NOT simply use the terms M_A, M_W, M_S, V_A, V_W and/or V_S).

(3 marks)

(c) During a test using a constant-head permeameter, the following data were collected as shown in Table Q5(a). Determine the average value of k

Table Q5(a)

Quantity collected in 2 mins	541	503	509
Difference in manometer levels (mm)	76	72	68

Diameter of the sample = 100mm

Temperature of water = 17 degree Celsius

hjkDistance between manometer tapping points = 150mm

(6 marks)

Question 5 continued over the page

Please turn the page

Question 5 continued

(d) A British standard 2.5kg "light" compaction test on a soil sample (G_s = 2.75) gave the following results:

Table Q5(b)

Moisture Content (%)	Bulk Density (kg/m^3)
6.5	1860
8.7	2049
10.4	2146
12.	2180
14.2	2140
16	2070

(i) Using the data provided in the above table, plot the compaction curve on **Figure Q5a** to obtain the maximum dry density and the optimum water content.

(8 marks)

(ii) Calculate the air void content for the soil at 9% moisture content.

(3 marks)

Question 5 continued over the page

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Question 5 continued

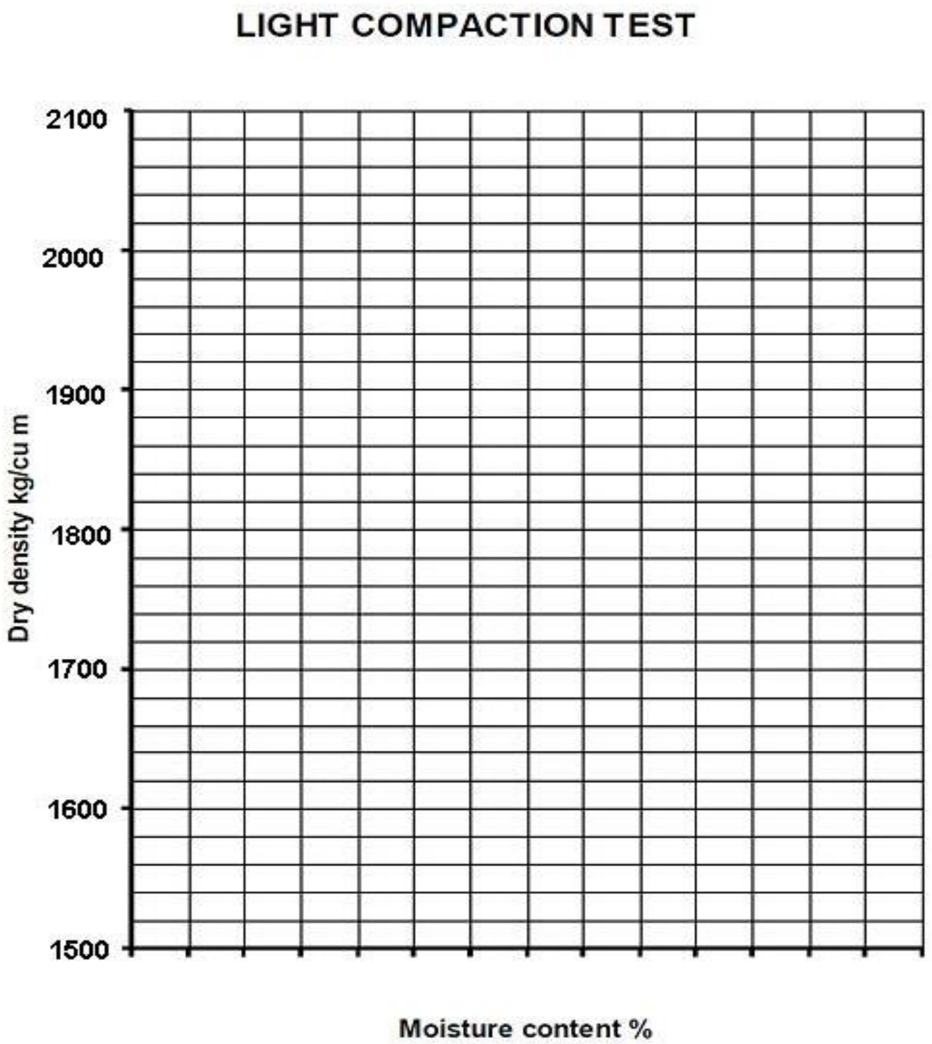

FIGURE Q5a.

Candidate Number……………………….

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Total 25 marks

END OF SECTION B

END OF QUESTIONS

Please turn the page for formula sheet for Section A

Please turn the page

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Formula sheet for Section A.

$P = \rho g h$

$Q = AV$

$$\frac{P_1}{\rho g} + \frac{v_1^2}{2g} + z_1 = \frac{P_2}{\rho g} + \frac{v_2^2}{2g} + z_2 + hf + hL$$

$$h_f = \frac{\lambda L v^2}{2g\, d} = \frac{\lambda\, L\, Q^2}{12.1\, d^5}$$

$$h_f = S_0 \; x \; L$$

$h_L = K_L \dfrac{v^2}{2g}$; $K_{L \text{ entry to pipe}} = 0.5$; $K_{L \text{ exit from pipe}} = 1.0$

$$h_{L \text{ expansion}} = \frac{(v_1 - v_2)^2}{2g}$$

$$Q = \frac{A}{n} R^{2/3} \; S_o^{1/2}$$

$$R = \frac{A}{P}$$

Please turn the page formula sheet for Section B

Please turn the page

Formula sheet for Section B.

TERMINOLOGY, SYMBOLS AND UNITS

Term	Symbol	Units
Volume	V	m^3
Litre	l	Litre (= 1×10^{-3} m^3)
Mass	M	kg
Gravity	g	9.81 m/sec^2
Weight		kN = (kg x 9.81)/1000
Total volume	V	m^3
Volume of air	V_A	m^3
Volume of water	V_W	m^3
Volume of voids	V_V	m^3
Volume of solids	V_S	m^3
Mass of water	M_W	kg
Mass of solids	M_S	kg
Weight of water	W_W	kN
Weight of solids	W_S	kN
Total weight	W	kN
Specific gravity	G_s	None
Density of water	ρ_w	1000 kg/m^3
Unit weight of water	γ_w	9.81 kN/m^3
Void ratio	e	None
Degree of saturation	S_r	None
Moisture content	w	None
Porosity	n	None
Air void content	A_v	None
Bulk density	ρ_b	kg/m^3
Dry density	ρ_d	kg/m^3
Saturated density	ρ_{sat}	kg/m^3
Bulk unit weight	γ_b	kN/m^3
Dry unit weight	γ_d	kN/m^3
Saturated unit weight	γ_{sat}	kN/m^3

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FORMULAE

	Density kg/m³	Unit weight kN/m³
1	$\rho_b = \dfrac{\rho_W (G_s + e\,S_r)}{1 + e}$	$\gamma_b = \dfrac{\gamma_W (G_s + e\,S_r)}{1 + e}$
2	$\rho_b = \dfrac{\rho_W G_s (1 + w)}{1 + e}$	$\gamma_b = \dfrac{\gamma_W G_s (1 + w)}{1 + e}$
3	$\rho_d = \dfrac{\rho_W G_s}{1 + e}$	$\gamma_d = \dfrac{\gamma_W G_s}{1 + e}$
4	$\rho_{sat} = \dfrac{\rho_W (G_s + e)}{1 + e}$	$\gamma_{sat} = \dfrac{\gamma_W (G_s + e)}{1 + e}$

5 $$w\,G_s = e\,S_r$$

Transposing the above expressions:

	From 3 above;	From 3 above;
6	$e = \dfrac{\rho_W G_s}{\rho_d} - 1$	$e = \dfrac{\gamma_W G_s}{\gamma_d} - 1$
7	$\rho_d \max = \dfrac{\rho_W G_s (1 - A_v)}{1 + w\,G_s}$	$\gamma_d \max = \dfrac{\gamma_W G_s (1 - A_v)}{1 + w\,G_s}$

8 $$k = \frac{2.30\,aL}{A(t_2 - t_1)} .\log_{10}(h_1/ h_2)$$

9 $$k = \frac{q}{Ai} = \frac{qL}{Ah}$$

10. Hazen's Formula , $k = C.(D_{10})^2$

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DEFINITIONS

Density of water, ρ_w	mass of water / volume of water	$\frac{M_w}{V_w}$
Unit weight of water, γ_w	weight of water / volume of water	$\frac{W_w}{V_w}$
Specific gravity, G_s	density of solids / density of water	$\frac{\rho_s}{\rho_w}$
Moisture content, w	mass of water / mass of solids	$\frac{M_w}{M_s}$
Void ratio, e	volume of voids / volume of solids	$\frac{V_v}{V_s}$
Degree of saturation, S_r	volume of water / volume of voids	$\frac{V_w}{V_v}$
Porosity, n	volume of voids / total volume	$\frac{V_v}{V}$
Bulk density, ρ_b	total mass / total volume	$\frac{M}{V}$
Dry density, ρ_d	mass of solids / total volume	$\frac{M_s}{V}$
Saturated density, ρ_{sat}	total saturated mass / total volume	$\frac{M}{V}$
Bulk unit weight, γ_b	total weight / total volume	$\frac{W}{V}$
Dry unit weight, γ_d	weight of solids / total volume	$\frac{W_s}{V}$
Saturated unit weight, γ_{sat}	total saturated weight / total volume	$\frac{W}{V}$

END OF PAPER