Name _____ Index No. _____/_____

2705/202 2709/202
2707/202 2710/202
STRUCTURES II, GEOTECHNOLOGY II AND CONCRETE TECHNOLOGY II
Oct/Nov. 2014
Time: 3 hours

Candidate's Signature _____

Date _____

THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN BUILDING TECHNOLOGY
DIPLOMA IN CIVIL ENGINEERING
DIPLOMA IN ARCHITECTURE

STRUCTURES II, GEOTECHNOLOGY II AND
CONCRETE TECHNOLOGY II

3 hours

INSTRUCTIONS TO CANDIDATES

Write your name and index number in the spaces provided above.
Sign and write the date of examination in the spaces provided above.
You should have drawing instruments and Scientific Calculator for this examination.
*This paper consists of **EIGHT** questions in **THREE** sections **A**, **B** and **C**.*
*Answer **TWO** questions from section **A**, **TWO** questions from section **B** and **ONE** question from section **C**.*
All questions carry equal marks.
Maximum marks for each part of a question are as shown.
Candidates should answer the questions in English.

For Examiner's Use Only

Section	Question	Maximum Score	Candidate's Score
A	1	20	
	2	20	
	3	20	
B	4	20	
	5	20	
	6	20	
C	7	20	
	8	20	
Grand Total		100	

This paper consists of 20 printed pages.

Candidates should check the question paper to ascertain that all the pages are printed as indicated and that no questions are missing.

Turn over

SECTION A: STRUCTURES II

*Answer **TWO** questions from this section.*

1. A column of size 200 x 400 mm has a hole of size 100 mm diameter located off centre as shown in figure 1. The column carries three axial loads of magnitude 400 kN, 200 kN and 100 kN positioned as shown. Determine:

   (a) the magnitude and position of the resultant load;
   (b) the stresses at the corners A, B, C and D.

   (20 marks)

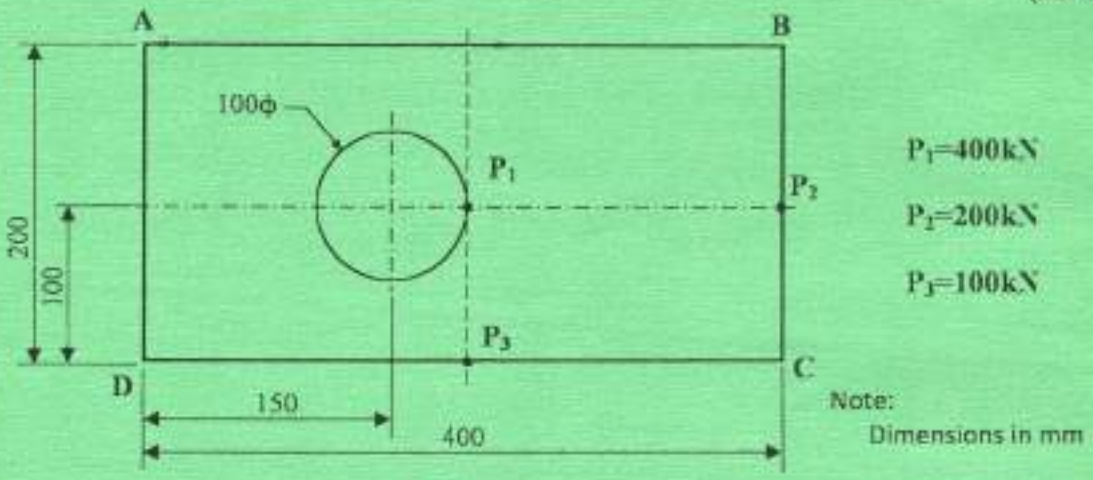

Fig. 1

2. (a) State the object of limit state design and outline **three** seviceability limit states.

   (4 marks)

   (b) Design a simply supported reinforced concrete beam given the following information:

   - beam section is 300 mm wide and 600 mm deep.
   - beam spans 6 m between centres of 300 mm wide supporting piers.
   - beam carries dead and imposed loads of 25 kN/m and 19 kN/m respectively.
   - allowable stresses are: $f_{cu} = 30N/mm^2$, $f_y = 460N/mm^2$, $f_{yv} = 250N/mm^2$.
   - Exposure condition is mild.

   Use the information in Tables 1 to Table 6.

   (16 marks)

3. A reinforced concrete retaining wall of density 2400 kg/m^3 supports cohesionless soil of density 2000 kg/m3 and of angle of shearing resistance (Φ) of 30° as shown in figure 2. Determine:

(a) the position at which the ground reaction cuts the base from the toe;
(b) the ground bearing pressure;
(c) the factor of safety against overturning;
(d) the factor of safety against sliding, assuming angle of wall friction (δ) is equal to the angle of shearing resistance (Φ). (20 marks)

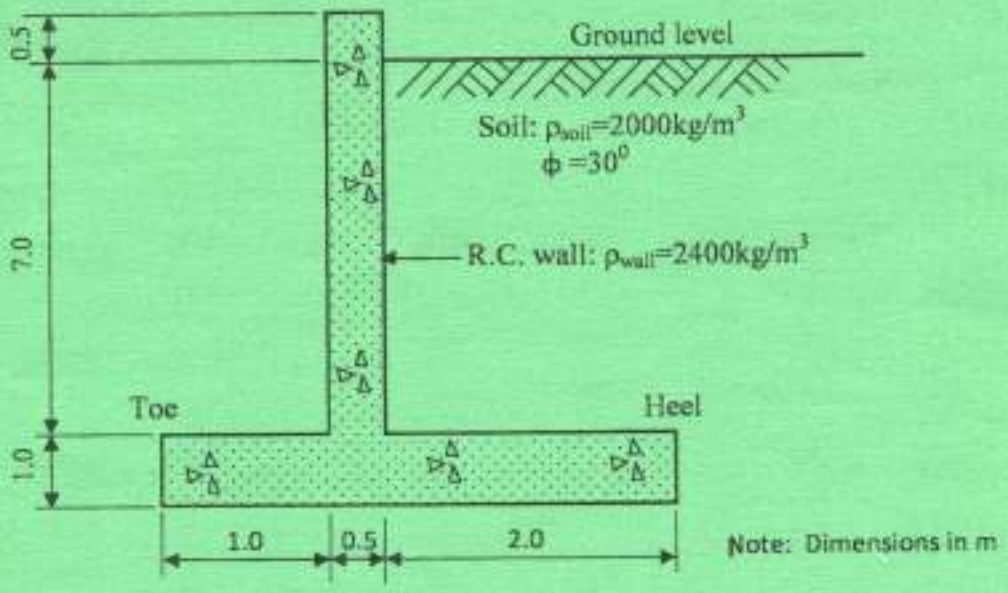

Fig. 2

SECTION B: GEOTECHNOLOGY II

*Answer **TWO** questions from this section.*

4. (a) Explain **two** factors which affect the selection of a particular type of dam. (9 marks)

(b) State **three** advantages and **three** disadvantages of tunnel boring machines. (6 marks)

(c) Describe the mechanical weathering process. (5 marks)

5. (a) Describe the **three** recognition criteria for geological faults in the field. (9 marks)

(b) Outline **three** categories of weak zones as geological problems in tunnelling. ($7\frac{1}{2}$ marks)

(c) State **seven** precautions taken while storing and handling explosives. ($3\frac{1}{2}$ marks)

6. (a) Explain the following stages in the extraction process for hard-rock quarrying:

(i) primary fragmentation;
(ii) secondary fragmentation.

(10 marks)

(b) (i) Describe a geological map.
(ii) Explain the use of a geological map.

(5 marks)

(c) State **five** chemical weathering processes. ($2\frac{1}{2}$ marks)

(d) State **five** types of initial support systems. ($2\frac{1}{2}$ marks)

SECTION C: CONCRETE TECHNOLOGY II

*Answer **ONE** question from this section.*

7. (a) Discuss concrete batching plants. (7 marks)

(b) State **seven** advantages of precase concrete units over in-situ concrete. (7 marks)

(c) Describe the following types of formwork:

(i) milled foam moulds;
(ii) textile formwork.

(6 marks)

8. (a) (i) Define the term prestressed concrete;
(ii) Differentiate between pretensioning and posttensioning in prestressed concrete work.

(5 marks)

(b) Distinguish between construction and functional joints. (3 marks)

(c) State **six** precautions taken to minimize the adverse effects of hot weather in concreting. (6 marks)

(d) Outline **four** advantages of prestressed concrete over reinforced concrete.

(6 marks)

Table 1: Nominal cover to all reinforcement (including links) to meet durability requirements

Conditions of exposure	Nominal cover (mm)				
Mild	25	20	20	20	20
Moderate	-	35	30	25	20
Severe	-	-	40	30	25
Very severe	-	-	50	40	30
Extreme	-	-	-	60	50
Maximum free water/cement ratio	0.65	0.60	0.55	0.50	0.45
Minimum cement content (kgm^{-3})	275	300	325	350	400
Lowest concrete grade	C30	C35	C40	C45	C50

Table 2: Values of design concrete shear stress, v_c (Nmm^{-2})

$\frac{100A_s}{bd}$	Effective depth (d) (mm)							
	125	150	175	200	225	250	300	≥400
≤0.15	0.45	0.43	0.41	0.40	0.39	0.38	0.36	0.34
0.25	0.53	0.51	0.49	0.47	0.46	0.45	0.43	0.40
0.50	0.67	0.64	0.62	0.60	0.58	0.56	0.54	0.50
0.75	0.77	0.73	0.71	0.68	0.66	0.65	0.62	0.57
1.00	0.84	0.81	0.78	0.75	0.73	0.71	0.68	0.63
1.50	0.97	0.92	0.89	0.86	0.83	0.81	0.78	0.72
2.00	1.06	1.02	0.98	0.95	0.92	0.89	0.86	0.80
≥3.00	1.22	1.16	1.12	1.08	1.05	1.02	0.98	0.91

Table 3: Values of A_{sv}/s_v, v_c (Diameter and spacing of links), (RC design-BS 8110)

Diameter of links (mm)	Spacing of links (mm)										
	85	90	100	125	150	175	200	225	250	275	300
8	1.183	1.118	1.006	0.805	0.671	0.575	0.503	0.447	0.402	0.336	0.335
10	1.847	1.744	1.57	1.256	1.047	0.897	0.785	0.698	0.628	0.571	0.523
12	2.659	2.511	2.26	1.808	1.507	1.291	1.13	1.004	0.904	0.822	0.753
16	4.729	4.467	4.02	3.216	2.68	2.297	2.01	1.787	1.608	1.462	1.34

Table 4: Form, area and spacing of links in beams

Values of v (N/mm^2)	*Area of shear reinforcement to be provided*
$v < 0.5v_c$ throughout the beam	No links required but normal practice to provide nominal links in members of structural importance
$0.5v_c < v < (v_c + 0.4)$	Nominal (or minimum) links for whole length of beam $A_{sv} \geq 0.4bs_v / 0.87f_{yv}$
$(v_c + 0.4) < v < 0.8\sqrt{f_{cu}}$ Or $5N/mm^2$	Design links $A_{sv} \geq bs_v (v - v_c) / 0.87f_{yv}$

Table 5: Key Equations for RC design to BS 8110 (with usual notations)

1.	$z = d\left[0.5 + \sqrt{(0.25 - K/0.9)}\right]$, where $K = \frac{M}{f_{cu}bd^2}$
2.	$z = d\left[0.5 + \sqrt{(0.25 - K/0.9)}\right]$, where $K = \frac{M}{f_{cu}bd^2}$
3.	Shear stress factor for concrete of grade 25: $(f_{cu}/25)^{1/3}$
4.	Design service stress in tension reinforcement, $fs = 5fy\frac{A_s, req}{8A_s, prov} \times \frac{1}{\beta_b}$, where β_b is the percentage moment distribution=1for simply supported beams.

Table 6: Reinforcement-bar areas (mm^2) per metre width for various bar spacings

Bar Diameter (mm)	Bar spacing (mm)									
	75	100	125	150	175	200	225	250	275	300
6	377	283	226	189	162	142	126	113	103	94
8	671	503	402	335	287	252	223	201	183	168
10	1047	785	628	523	449	393	349	314	286	262
12	1508	1131	905	754	646	566	503	452	411	377
16	2681	2011	1608	1340	1149	1005	894	804	731	670
20	4189	3142	2513	2094	1795	1571	1396	1257	1142	1047
25	6545	4909	3927	3272	2805	2454	2182	1963	1785	1636
32	-	8042	6434	5362	4596	4021	3574	3217	2925	2681
40	-	-	10050	8378	7181	6283	5585	5027	4570	4189

Areas of group of reinforcement bars (mm^2)

Bar Diameter (mm)	Number of bars									
	1	2	3	4	5	6	7	8	9	10
6	28	57	85	113	141	170	198	226	254	283
8	50	101	151	201	251	302	352	402	452	503
10	79	157	236	314	393	471	550	628	707	785
12	113	226	339	452	565	679	792	905	1017	1131
16	201	402	603	804	1005	1206	1407	1608	1809	2011
20	314	628	942	1257	1571	1885	2199	2513	2827	3142
25	491	982	1473	1963	2454	2945	3436	3927	4418	4909
32	804	1608	2412	3216	4021	4825	5629	6433	7237	8042
40	1256	2513	3769	5026	6283	7539	8796	10050	11310	12570