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2705/202 2709/202
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STRUCTURES II, GEOTECHNOLOGY II
AND CONCRETE TECHNOLOGY II
Oct./Nov. 2018
Time: 3 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN BUILDING TECHNOLOGY
DIPLOMA IN CIVIL ENGINEERING
DIPLOMA IN ARCHITECTURE

MODULE II

STRUCTURES II, GEOTECHNOLOGY II AND CONCRETE TECHNOLOGY II

3 hours

INSTRUCTIONS TO CANDIDATES

You should have the following for this examination:
answer booklet;
scientific calculator/ mathematical tables;
drawing instruments.
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*** *in the answer booklet provided.*
All questions carry equal marks.
Maximum marks for each part of a question are as indicated.
Candidates should answer the questions in English.

This paper consists of 9 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) Using Mohr's theorems, derive equations for maximum deflection and maximum slope for a simply supported beam of span ℓ carrying a uniform distributed load unit length over the entire span. (10 marks)

   (b) **Figure 1** shows a loaded cantilever beam. Using Macauley's method, determine the slope and deflection a the free end of the beam (point B). Take EI = constant. (10 marks)

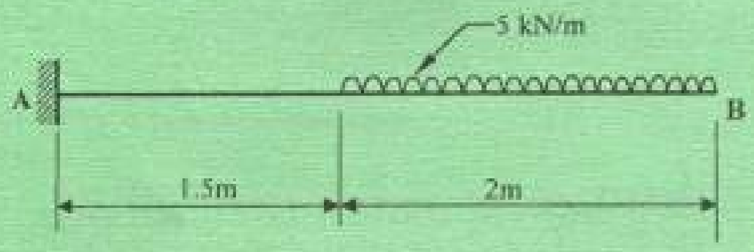

Fig. 1

2. (a) With the aid of sketches, explain any **four** modes of failure in masonry retaining walls. (10 marks)

   (b) **Figure 2** shows a cross-section of a column transmitting the load to the base. Determine the extreme stresses at points A, B, C and D. (10 marks)

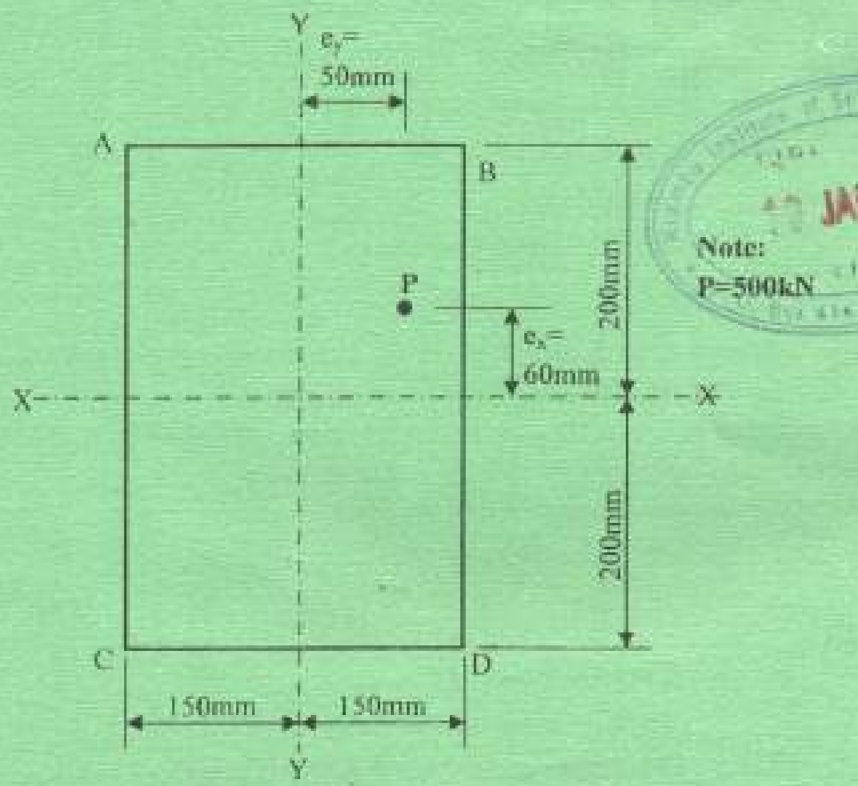

Fig. 2

3. **Figure 3** shows a slab restrained in the four sides (slab casted monolithically with beam). Design the slab given the following information:

Information:

- imposed load = 4.0 kN/m^2,
- finishes = 0.6 kN/m^2,
- concrete mix = 1:2:4,
- characteristic material strengths,

  $f_{cu} = 30$ N/mm^2

  $f_y = 460$ N/mm^2,

- thickness of slab = 200 mm
- exposure condition is moderate
- use design tables 1 - 9 attached.

(20 marks)

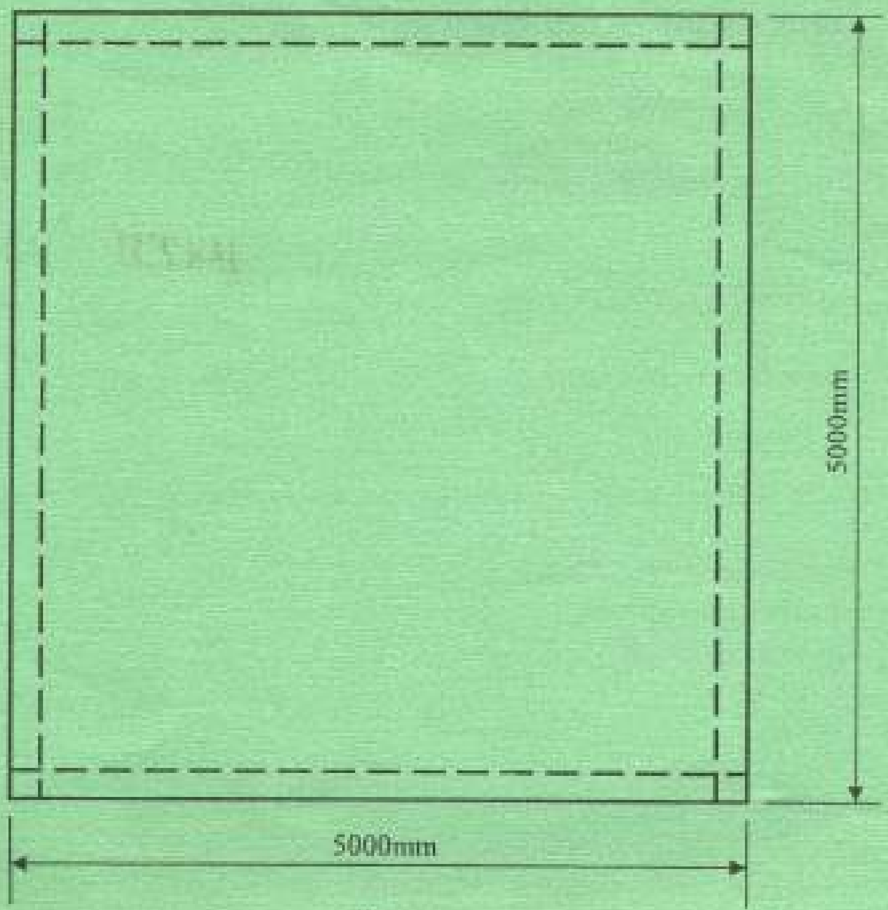

Fig. 3

SECTION B: GEOTECHNOLOGY II

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

4. (a) (i) Outline **two** negative and **two** positive effects of geological faulting in Kenya.

(ii) With the aid of sketches, describe **three** causes of geological faulting.

(10 marks)

(b) Outline each of the following weathering processes:

(i) physical weathering;
(ii) chemical weathering.

(3 marks)

(c) (i) Define Geological maps.

(ii) Explain each of the following types of maps:

(I) isopachyte maps;
(II) geophysical maps;
(III) structural contour maps.

(7 marks)

5. (a) (i) State **two** functions of a dam.

(ii) Name **four** types of dams.

(4 marks)

(b) Explain each of the following as used in dams and reservoirs:

(i) storage capacity and head;
(ii) foundation conditions;
(iii) conceptual design;
(iv) conveyances.

(8 marks)

(c) State **four** environmental hazards caused by quarrying of stones. (4 marks)

(d) Explain each of the following methods of quarrying stones:

(i) extraction;
(ii) dressing of stone.

(4 marks)

6. (a) State **five** factors considered before tunnelling operation commences. (5 marks)

(b) Explain the purpose of ventilation in tunnel construction. (3 marks)

(c) With the aid of sketches, describe each of the following methods of tunnelling:

(i) open cut method;
(ii) pre-deck method;
(iii) immersed tube system.

(12 marks)

SECTION C: CONCRETE TECHNOLOGY II

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

7. (a) Describe the architectural precast stone class of the precast concrete. (5 marks)

(b) Explain how large - panel precast concrete units are fixed under each of the following:

(i) wet joints;
(ii) dry joints;
(iii) groove joints.

(6 marks)

(c) With aid of a sketch, describe an expansion joint. (9 marks)

8. (a) State **eight** precautions to be taken when concreting in hot weather. (8 marks)

(b) Describe the post-tensioning method of prestressing concrete. (6 marks)

(c) Describe the hand-fed tilting drum mixer. (6 marks)

Table 1 — Nominal cover to all reinforcement (including links) to meet durability requirements (see NOTE 1)

Conditions of exposure (see 3.3.4)	Nominal cover Dimensions in millimetres				
Mild	25	20	20[a]	20[a]	20[a]
Moderate	—	35	30	25	20
Severe	—	—	40	30	25
Very severe	—	—	50[b]	40[b]	30
Most severe	—	—	—	—	50
Abrasive	—	—	—	See NOTE 3	See NOTE 3
Maximum free water/cement ratio	0.65	0.60	0.55	0.50	0.45
Minimum cement content (kg/m^3)	275	300	325	350	400
Lowest grade of concrete	C30	C35	C40	C45	C50

NOTE 1 This table relates to normal-weight aggregate of 20 mm nominal size. Adjustments to minimum cement contents for aggregates other than 20 mm nominal maximum size are detailed in Table 8 of BS 5328-1:1997.

NOTE 2 Use of sulfate resisting cement conforming to BS 4027. These cements have lower resistance to chloride ion migration. If they are used in reinforced concrete in very severe or most severe exposure conditions, the covers in Table 3.3 should be increased by 10 mm.

NOTE 3 Cover should be not less than the nominal value corresponding to the relevant environmental category plus any allowance for loss of cover due to abrasion.

[a] These covers may be reduced to 15 mm provided that the nominal maximum size of aggregate does not exceed 15 mm.

[b] Where concrete is subject to freezing whilst wet, air-entrainment should be used (see 5.3.3 of BS 5328-1:1997) and the strength grade may be reduced by 5.

Table 2 — Nominal cover to all reinforcement (including links) to meet specified periods of fire resistance (see NOTE 1 and NOTE 2)

Fire resistance h	Nominal cover						
	Beams[a]		Floors		Ribs		Columns[a] mm
	Simply supported mm	Continuous mm	Simply supported mm	Continuous mm	Simply supported mm	Continuous mm	
0.5	20[b]	20[b]	20[b]	20[b]	20[b]	20[b]	20[b]
1	20[b]	20[b]	20	20	20	20[b]	20[b]
1.5	20	20[b]	25	20	35	20	20
2	40	30	35	25	45	35	25
3	60	40	45	35	55	45	25
4	70	50	55	45	65	55	25

NOTE 1 The nominal covers given relate specifically to the minimum member dimensions given in Figure 3.2. Guidance on increased covers necessary if smaller members are used is given in section 4 of BS 8110-2:1985.

NOTE 2 Cases that lie below the bold line require attention to the additional measures necessary to reduce the risks of spalling (see section 4 of BS 8110-2:1985).

[a] For the purposes of assessing a nominal cover for beams and columns, the cover to main bars which would have been obtained from Tables 4.2 and 4.3 of BS 8110-2:1985 has been reduced by a notional allowance for stirrups of 10 mm to cover the range 8 mm to 12 mm (see also 3.3.6).

[b] These covers may be reduced to 15 mm provided that the nominal maximum size of aggregate does not exceed 15 mm (see 3.3.1.3).

Table 3 — Values of v_c design concrete shear stress

$\frac{100A_s}{b_v d}$	Effective depth mm							
	125	150	175	200	225	250	300	≥ 400
	N/mm^2	N/mm^2	N/mm^2	N/mm^2	N/mm^2	N/mm^2	N/mm^2	N/mm^2
≤ 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

NOTE 1 Allowance has been made in these figures for a γ_m of 1.25.

NOTE 2 The values in the table are derived from the expression:

$0.79\{100A_s/(b_v d)\}^{1/3}(400/d)^{1/4}/\gamma_m$

where

$\frac{100A_s}{b_v d}$ should not be taken as greater than 3;

$\frac{400}{d}$ should not be taken as less than 1

For characteristic concrete strengths greater than 25 N/mm^2, the values in this table may be multiplied by $(f_{cu}/25)^{1/3}$. The value of f_{cu} should not be taken as greater than 40.

Table 4 — Basic span/effective depth ratio for rectangular or flanged beams

Support conditions	Rectangular section	Flanged beams with $\frac{b_w}{b} \leq 0.3$
Cantilever	7	5.6
Simply supported	20	16.0
Continuous	26	20.8

Table 5 — Modification factor for tension reinforcement

Service stress	M/bd^2								
	0.50	0.75	1.00	1.50	2.00	3.00	4.00	5.00	6.00
100	2.00	2.00	2.00	1.86	1.63	1.36	1.19	1.08	1.01
150	2.00	2.00	1.98	1.69	1.49	1.25	1.11	1.01	0.94
(f_y = 250) 167	2.00	2.00	1.91	1.63	1.44	1.21	1.08	0.99	0.92
200	2.00	1.95	1.76	1.51	1.35	1.14	1.02	0.94	0.88
250	1.90	1.70	1.55	1.34	1.20	1.04	0.94	0.87	0.82
300	1.60	1.44	1.33	1.16	1.06	0.93	0.85	0.80	0.76
(f_y = 460) 307	1.56	1.41	1.30	1.14	1.04	0.91	0.84	0.79	0.76

NOTE 1 The values in the table derive from the equation:

$$\text{Modification factor} = 0.55 + \frac{(477 - f_s)}{120\left(0.9 + \frac{M}{bd^2}\right)} \leq 2.0 \qquad \text{equation 7}$$

where

M is the design ultimate moment at the centre of the span or, for a cantilever, at the support.

NOTE 2 The design service stress in the tension reinforcement in a member may be estimated from the equation:

$$f_s = \frac{2 f_y A_{s\,req}}{3 A_{s\,prov}} \times \frac{1}{\beta_b} \qquad \text{equation 8}$$

NOTE 3 For a continuous beam, if the percentage of redistribution is not known but the design ultimate moment at mid-span is obviously the same as or greater than the elastic ultimate moment, the stress f_s in this table may be taken as $2/3 f_y$

Table 6 — Bending moment coefficients for slabs spanning in two directions at right angles, simply-supported on four sides

l_y/l_x	1.0	1.1	1.2	1.3	1.4	1.5	1.75	2.0
α_{sx}	0.062	0.074	0.084	0.093	0.099	0.104	0.113	0.118
α_{sy}	0.062	0.061	0.059	0.055	0.051	0.046	0.037	0.029

Table 7 Cross-sectional areas of groups of bars (mm)

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

Table 8 — Form and area of shear reinforcement in solid slabs

Value of v N/mm²	Form of shear reinforcement to be provided	Area of shear reinforcement to be provided
$v < v_c$	None required	None
$v_c < v < (v_c + 0.4)$	Minimum links in areas where $v > v_c$	$A_{sv} \geq 0.4bs_v/0.95f_{yv}$
$(v_c + 0.4) < v < 0.8\sqrt{f_{cu}}$ or 5 N/mm²	Links and/or bent-up bars in any combination (but the spacing between links or bent-up bars need not be less than d)	Where links only provided: $A_{sv} \geq bs_v(v - v_c)/0.95f_{yv}$ Where bent-up bars only provided: $A_{sb} \geq bs_b(v - v_c)/\{0.95f_{yv}$ $(\cos\alpha + \sin\alpha \times \cot\beta)\}$ (see 3.4.5.7)

NOTE 1 It is difficult to bend and fix shear reinforcement so that its effectiveness can be assured in slabs less than 200 mm deep. It is therefore not advisable to use shear reinforcement in such slabs.

NOTE 2 The enhancement in design shear strength close to supports described in **3.4.5.8**, **3.4.5.9** and **3.4.5.10** may also be applied to solid slabs.

Table 9 Cross-sectional area per metre width for various bar spacing (mm²)

Bar size (mm)	*Spacing of bars*								
	50	*75*	*100*	*125*	*150*	*175*	*200*	*250*	*300*
6	566	377	283	226	189	162	142	113	94.3
8	1010	671	503	402	335	287	252	201	168
10	1570	1050	785	628	523	449	393	314	262
12	2260	1510	1130	905	754	646	566	452	377
16	4020	2680	2010	1610	1340	1150	1010	804	670
20	6280	4190	3140	2510	2090	1800	1570	1260	1050
25	9820	6550	4910	3930	3270	2810	2450	1960	1640
32	16100	10700	8040	6430	5360	4600	4020	3220	2680
40	25100	16800	12600	10100	8380	7180	6280	5030	4190

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