2705/202
2707/202
2709/202
2710/202
STRUCTURES II, GEOTECHNOLOGY II,
AND CONCRETE TECHNOLOGY II
Oct./Nov. 2022
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.
*This paper consists of **EIGHT** questions in **THREE** sections; **A**, **B** and **C**.*
*Answer **TWO** questions from sections **A** and **B** and **ONE** question from section **C**.*
All questions carry equal marks.
Maximum marks for each part of a question are indicated.
Candidates should answer the questions in English.

This paper consists of 8 printed pages.

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

SECTION A: STRUCTURES II

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

1. (a) A short stanchion carries three loads; $P_1 = 50\,kN$, $P_2 = 20\,kN$ and $P_3 = 15\,kN$ as shown in **figure 1**. Determine:

(i) the position of the resultant load;

(ii) the intensity of stresses at the corners a, b, c and d.

The properties of the 254 mm x 254 mm x 73 kg/m universal column (UC) are shown in **table A**. (11 marks)

Table A

Series	254 mm x 254 mm x 73 kg/m UC
Area	$A = 92.9\ cm^2$
Second moment of area	$I_{xx} = 11360\ cm^4$, $I_{yy} = 3873\ cm^4$

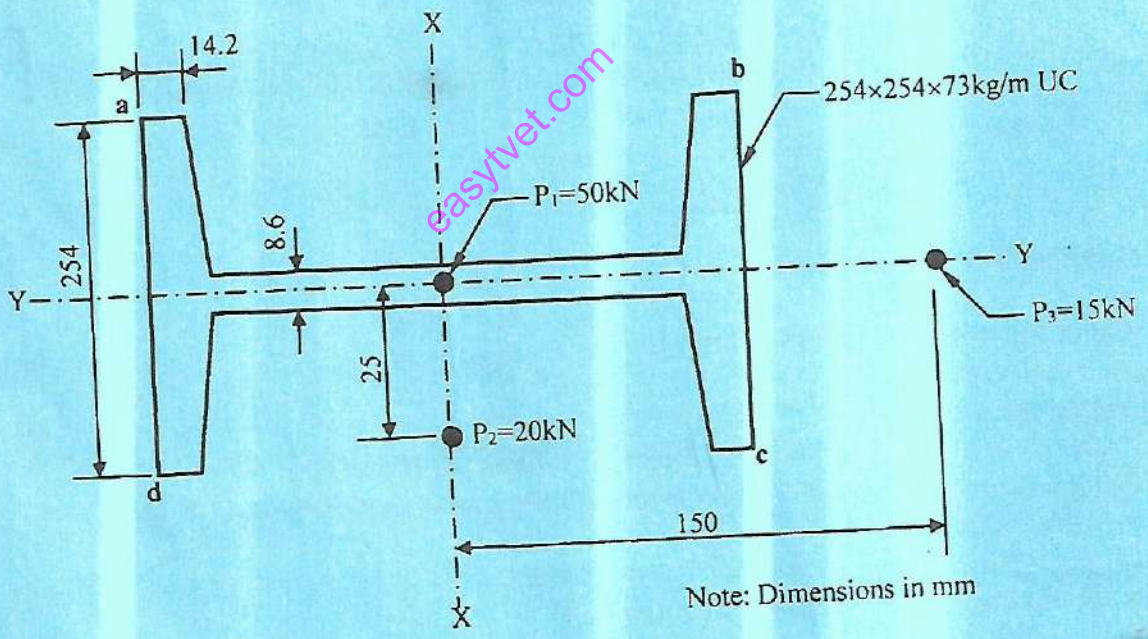

Fig. 1

(b) **Figure 2** shows a simply supported beam carrying a concentrated load at mid-span. Using Mohr's theorem, determine:

(i) the maximum deflection;

(ii) the slope and deflection at the quarter-span point D.

Take $EI = 120 \times 10^3$ kNm^2. (9 marks)

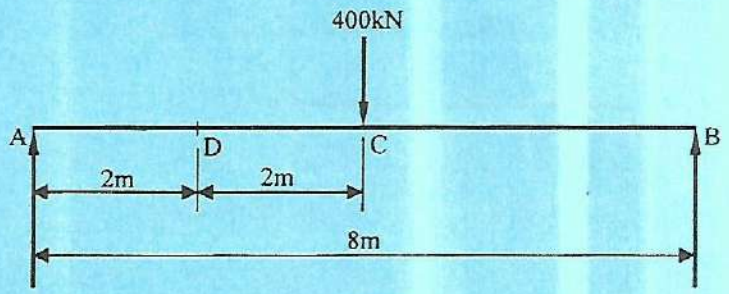

Fig. 2

2. **Figure 3** shows a masonry retaining wall of density 2400 kg/m^3 which retains soil of density 1800 kg/m^3 and angle of shearing resistance 30°. If a surcharge of 20 kN/m^2 is applied to the surface of the soil, examine the stability conditions of the wall with regard to:

(a) tension occurring in the joints; ($10\frac{1}{2}$ marks)

(b) ground bearing pressure; ($4\frac{1}{2}$ marks)

(c) factor of safety against overturning; (2 marks)

(d) factor of safety against sliding. (3 marks)

Take coefficient of wall friction $\mu = 0.6$, and the allowable ground bearing pressure as 300 kN/m^2.

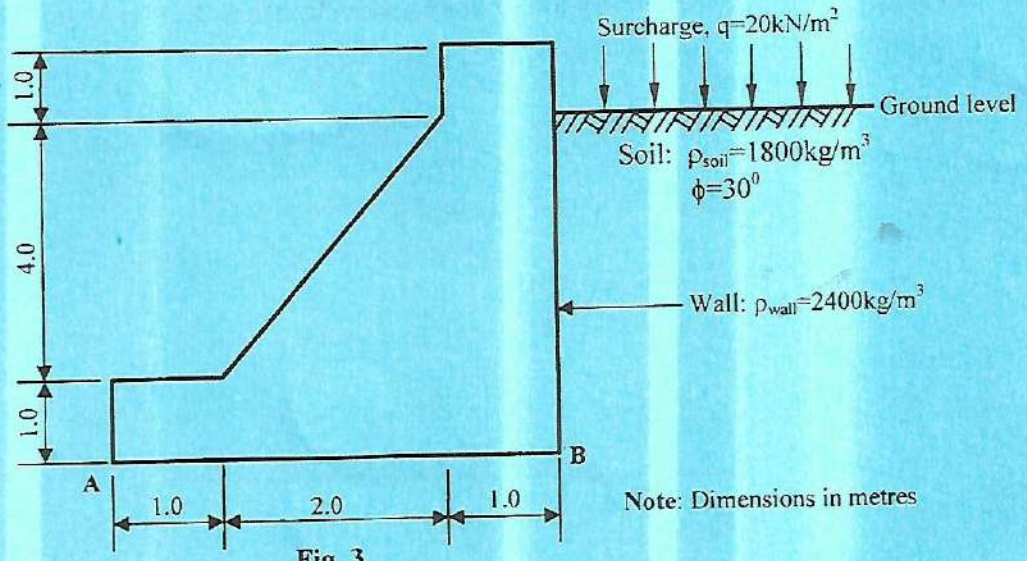

Fig. 3

3. (a) A reinforced concrete floor subject to an imposed load of 3 kN/m^2 spans between brick walls as shown in **figure 4**. Design the floor for mild exposure conditions assuming the following material strengths $fcu = 35$ N/mm^2 and $fy = 460$ N/mm^2. Use the information in Tables 1 - 6. (18 marks)

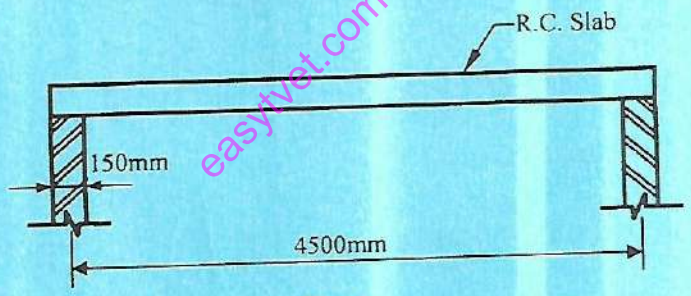

Fig. 4

(b) Sketch a section through the slab designed in (a) to show the reinforcement details. (2 marks)

SECTION C: CONCRETE TECHNOLOGY II

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

7. (a) (i) Explain what is meant by ready mixed concrete.

(ii) Outline **three** disadvantages of ready mixed concrete. ($6\frac{1}{2}$ marks)

(b) Describe the following pre-cast concrete elements:

(i) columns;

(ii) beams;

(iii) stairs. ($7\frac{1}{2}$ marks)

(c) Describe the tremie method of underwater concreting. (6 marks)

8. (a) (i) Describe a concrete batching plant.

(ii) Outline **two** types of concrete batching plants. (7 marks)

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

(c) Describe the following types of form work:

(i) milled foam moulds;

(ii) textile form work. (6 marks)

Table 1: Basic span : depth ratio for rectangular sections

Support conditions	Span/effective depth ratio (rectangular section)
Cantilever	7
Simply supported	20
Continuous	26

Table 2: Values of design concrete shear stress, v_c (N/mm^2)

$\frac{100As}{bd}$	*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: Modification factors 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
(fy=250)	156	2.00	2.00	1.96	1.66	1.47	1.24	1.10	1.00	0.94
	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
(fy=460)	288	1.68	1.50	1.38	1.21	1.09	0.95	0.87	0.82	0.78
	300	1.60	1.44	1.33	1.16	1.06	0.93	0.85	0.80	0.76

Table 4: Form and area of shear reinforcement in solid slabs

Values of v (N/mm^2)	Area of shear reinforcement to be provided
$v < v_c$ throughout the beam	None links required but normal practice to provide nominal links in members of structural importance
$v_c < v < (v_c + 0.4)$	Nominal links in areas where $v > v_c$ $A_{sv} \geq 0.4bs_v / 0.87f_{yv}$
$(v_c + 0.4) < v < 0.8\sqrt{f_{cu}}$ Or 5N/mm^2	Design links $A_{sv} \geq bs_v (v - v_c) / 0.87f_{yv}$

SECTION C: CONCRETE TECHNOLOGY II

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

7. (a) (i) Explain what is meant by ready mixed concrete.

(ii) Outline **three** disadvantages of ready mixed concrete. ($6\frac{1}{2}$ marks)

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(c) Describe the following types of form work:

(i) milled foam moulds;

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Table 5: 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 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

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