2705/202
2707/202
2709/202
2710/202
STRUCTURES II, GEOTECHNOLOGY II
AND CONCRETE TECHNOLOGY II
Oct. / Nov. 2021
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 at least **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 TWO questions from this section.

1. (a) **Figure 1** shows a loaded cantilever beam. Using Mohr's method, determine the maximum slope and deflection under the loads in terms of EI. (16 marks)

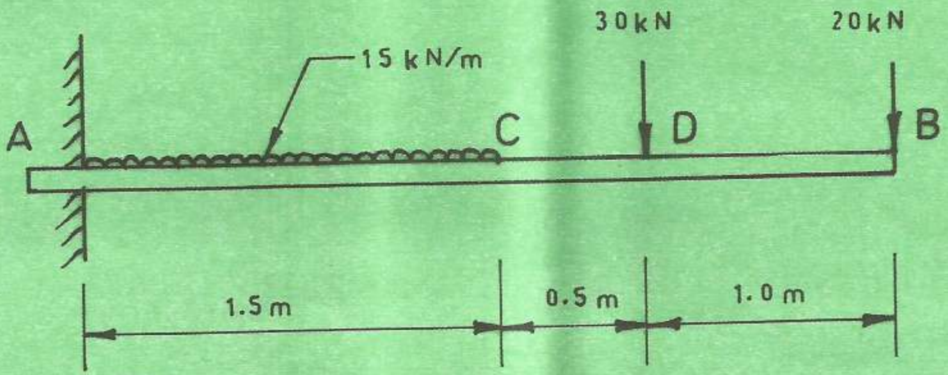

Fig. 1

(b) Define the following terms in relation to reinforced concrete design:

(i) serviceability limit state;
(ii) ultimate limit state.

(4 marks)

2. **Figure 2** shows a reinforced cantilever retaining wall backfilled with granular materials having unit weight of 20 kN/m³ and an internal angle of friction Ø of 30°. Given that the allowable ground bearing pressure as 150 kN/m², the coefficient of friction is 0.45 and unit weight of reinforced concrete is 24 kN/m³, determine:

(a) pressure at the toe and heel; (7 marks)

(b) factor of safety against overturning; (5 marks)

(c) factor of safety against sliding. (8 marks)

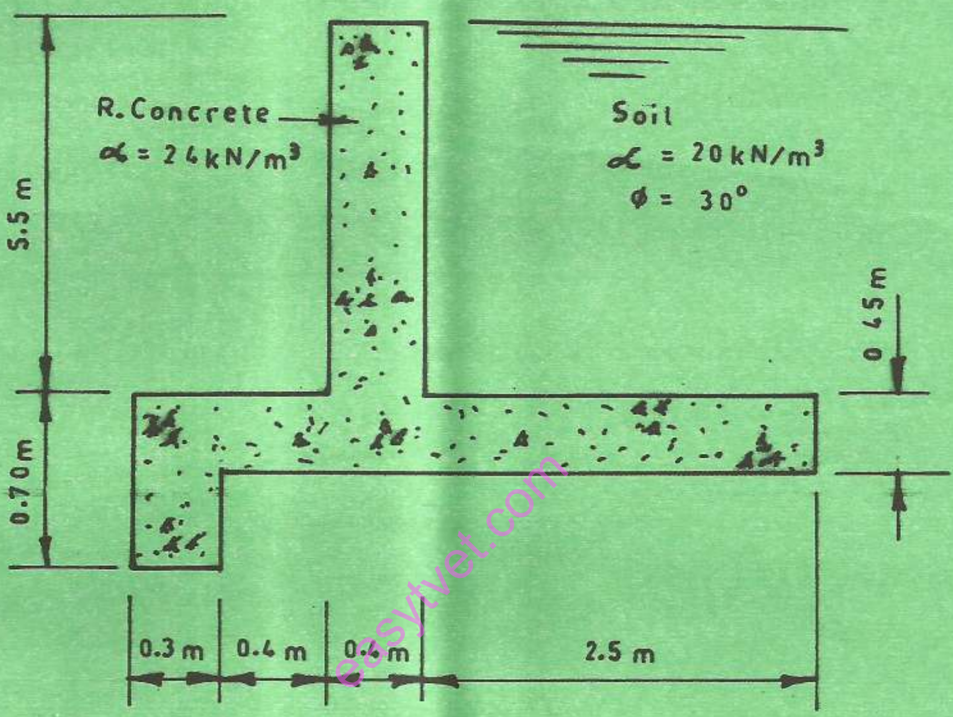

Fig. 2

3. Design and detail a simply supported reinforced concrete beam 1 shown in **figure 3.**

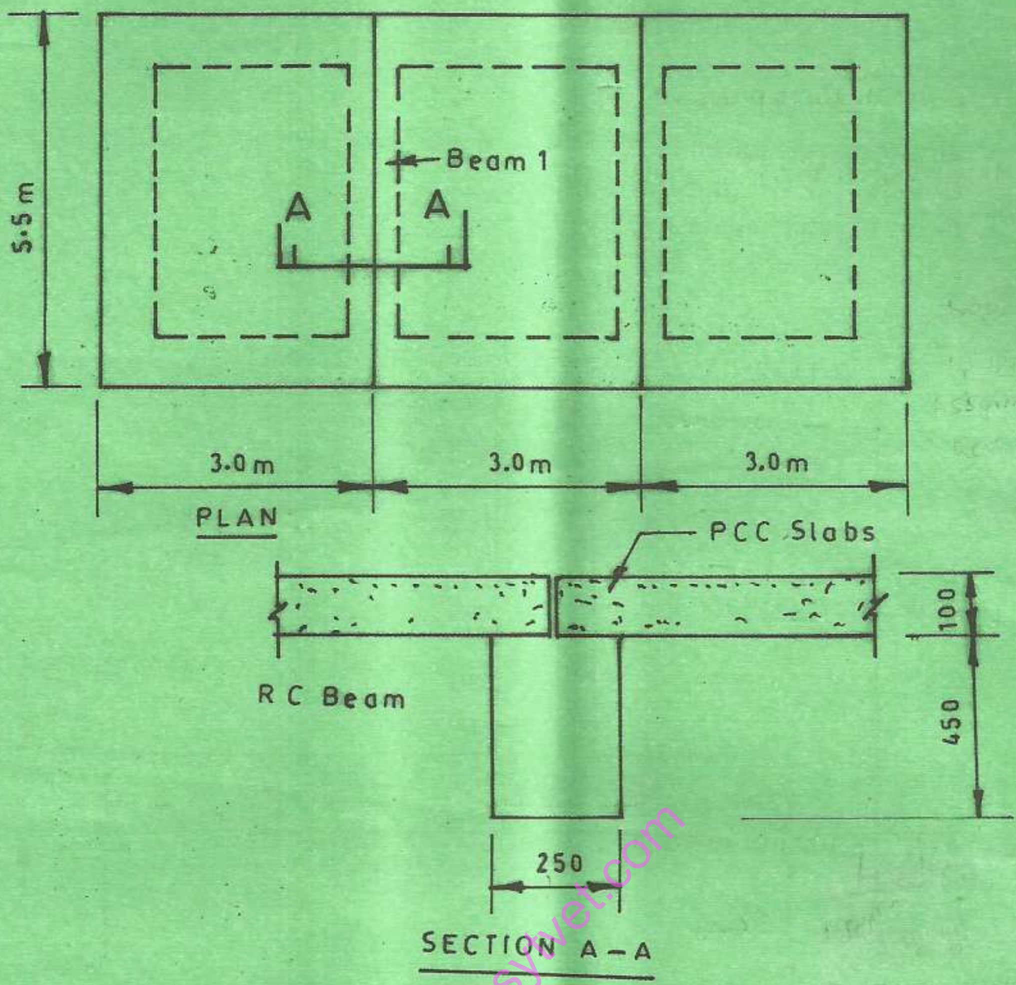

Fig. 3

Data:

imposed loads = 3.5 kN/m^2
finishes = 0.7 kN/m^2
partitions = 0.8 kN/m^2
f_{cu} = 35 N/mm^2
f_y = 460 N/mm^2
unit weight of concrete = 24 kN/m^3

(20 marks)

SECTION B: GEOTECHNOLOGY II

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

4. (a) Describe **three** processes of chemical weathering. (6 marks)

   (b) Explain **four** factors considered for dam site selection. (6 marks)

   (c) With the help of sketches, describe the following types of dams:

   (i) gravity dam;
   (ii) arch dam.

   (8 marks)

5. (a) Describe **five** precautions to be observed when blasting. (10 marks)

   (b) Explain **four** criteria for recognition of a geological fault in the field. (4 marks)

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

6. (a) Describe the following geological maps stating their uses:

   (i) sub-surface geological maps;
   (ii) isochore maps;
   (iii) structural contour maps;
   (iv) geophysical maps.

   (10 marks)

   (b) Explain the following features of a fault:

   (i) fault braccia;
   (ii) fault gauge;
   (iii) fault drag;
   (iv) slicken sides;
   (v) veins.

   (10 marks)

SECTION C: CONCRETE TECHNOLOGY

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

7. (a) State **five** advantages of pre-stressed concrete. (5 marks)

   - equipment used for make work easier, curing in controlled environment, specialised saves on time of construction, Reduce cost of const, const done on ground

   (b) Distinguish between pre-stressing and post-tensioning. (5 marks)

   - reinforcing Apply

   (c) Describe the following steps in the production of pre-cast concrete units:

   (i) types of moulds;
   (ii) assembly of moulds;
   (iii) casting;
   (iv) de-moulding.

   (10 marks)

8. (a) Explain **four** general precautions to be observed in hot weather concreting. (10 marks)

   (b) Explain **five** challenges associated with cold weather concreting. (10 marks)

Pre- beams are casted on stressing bed and casted on

Post- reinforcing of conc steel cable inside Plastic [illegible] duct.

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

Condition of exposure	Nominal cover				
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 (kg/m^3)	275	300	325	350	400
Lowest concrete grade	C30	C35	C40	C45	C50

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

$100A_s/bd$	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: Key Equations for RC design to BS8110 (with usual notations).

1.	$z=d\,[0.5+(0.25-K/0.9)^{1/2}]$. Where $K=M/f_{cu}bd^2$.
2.	Shear stress factor for concrete of grade 25: $(f_{cu}/25)^{1/3}$.
3.	Design service stress in tension reinforcement, $f_s=5\,f_yA_sreq/8\,A_sprov$.
4.	Modification factor$=0.55+(477-f_s)/120(0.9+M/bd^2)\leq 2.0$.
5.	Area of tension reinforcement $A=M/0.95f_yz$.

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 nominal practice to provide nominal links in members of structural importance.
$0.5<v<(v_c+0.4)$	Nominal (or minimum) links for whole length of beam $A_{sv}\geq 0.4bs_v/0.95f_{yv}$
$(v_c+0.4)<v<0.8(f_{cu})^{1/2}$ or 5N/mm^2	Design links $A_{sv}\geq bs_v(v-v_c)/0.95f_{yv}$.

Table 5: Values of A_{sv}/s_v, v_c diameter and spacing of links.

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	1.570	1.256	1.047	0.897	0.785	0.698	0.628	0.571	0.523
12	2.659	2.511	2.260	1.808	1.507	1.261	1.130	1.004	0.904	0.822	0.753
16	4.729	4.467	4.020	3.216	2.680	2.297	2.010	1.787	1.608	1.462	1.340

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

Table 7: 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	1071	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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