lxo

(University of Choice)

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

MAIN CAMPUS

UNIVERSITRY EXAMINATIONS
2021/2022 ACADEMIC YEAR

THIRD YEAR SECOND SEMESTER EXAMINATIONS

FOR THE DEGREE
OF
BACHELOR OF TECHNOLOGY
IN
BUILDING CONSTRUCTION

COURSE CODE: BTB 318

COURSE TITLE: CIVIL ENGINEERING CONSTRUCTION

DATE: THURSDAY 28TH APRIL 2022 TIME: 8:00 – 10:00 AM

INSTRUCTIONS:

1. This paper contains **FIVE** questions
2. Answer Question **One** and **Any Other Three** questions
3. Marks for each question are indicated in the parenthesis.
4. No unauthorized materials are allowed in the examination room
5. Examination duration is **2 Hours**

MMUST observes ZERO tolerance to examination cheating

This Paper Consists of 7 Printed Pages. Please Turn Over.

QUESTION 1

a) List and briefly describe all the parts of BS 8110. (6 marks)

b) Explain these terms:

(i) Ultimate state limit. (2marks)

(ii) Serviceability limit state. (2marks)

c) Figure 1 below is a simply supported reinforced concrete a rectangular beam of 275 mm width by 450 mm depth carrying uniformly distributed load including self-weight of 4 kN/m and an imposed weight of 5 kN/m. Design the beam for the following in accordance to BS 8110:

(i) Bending reinforcement (8 marks)

(ii) Shear reinforcement (4 marks)

(iii)Deflection (3 marks)

Design data:-

Exposure condition	Mild
Fire Resistance	$1^1/_2$ hrs
Concrete cube strength f_{cu}	25 N/mm^2
Steel characteristics strength f_y	500 N/mm^2

Taking the 10 mm diameter as the main reinforcement bars.

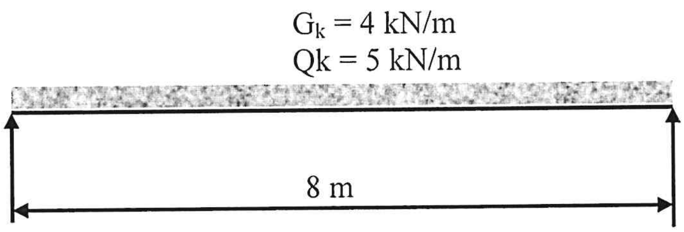

Figure 1

QUESTION 2

Figure 2 below is a 250 mm thick reinforced concrete floor slab with 10 mm diameter high yield steel bars and an imposed loading of 4 kN/m^2 spanning between the brick walls with the following design data:

f_{cu} = 25 N/mm^2		Concrete density ρ_c	= 24 kN/m^3
f_y = 500 N/mm^2		Fire resistance	= $1^1/_2$ hrs

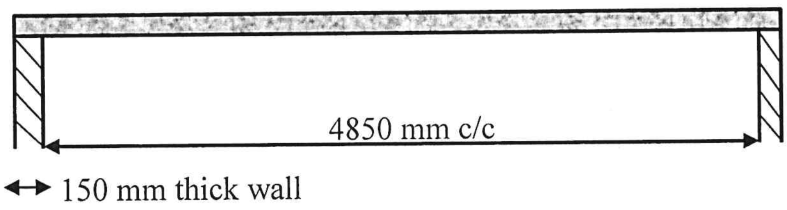

Figure 2

Design the floor for:

(i) Bending moment. (10 marks)

(ii) Check for deflection and cracking. (5 marks)

QUESTION 3

A short-braced column with f_{cu} = 40 N/mm^2 and f_y = 500 N/mm^2 is required to support an ultimate load axial load of 4000 kN. Determine a suitable square section for the column assuming that the area of longitudinal steel A_{sc} is of the order of 3% of the gross-sectional area of the column Acol. (15 marks)

QUESTION 4

A 800mm square column carries a dead lived G_k = 1200 kN and imposed load Q_k = 300 kN. The safe bending capacity of the soils is 170 kN/m^2. Design a square footing with an overall depth of 540 mm to carry the loading given the following (to BS 8110): Concrete characteristics strength f_{cu} = 25 N/mm^2, f_y = 500 N/mm^2, cover 50 mm and footing self-weigh = 125 kN. (15 marks)

QUESTION 5

The cantilever retaining wall shown below is backfilled with granular material having a unit weight, ρ, of 19 kNm^{-3} and an internal angle of friction, Φ, of 30°. Assuming that the allowable bearing pressure of the soil is 120 kNm^{-2}, the coefficient of friction is 0.4 and the unit weight of reinforced concrete is 24 kNm^{-3}.

1) Determine the factors of safety against sliding and overturning.
2) Calculate ground bearing pressures.
3) Design the wall and base reinforcement assuming f_{cu} = 35 kNm^{-2}, f_y = 500 kNm^{-2} and the cover to reinforcement in the wall and base are, respectively, 35 mm and 50 mm.

(15 marks)

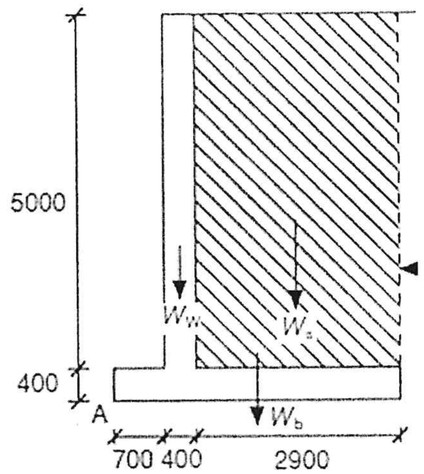

Table 1 Nominal cover to all reinforcement to meet specified periods of fire resistance (based on Table 3.4, BS 8110)

Fire resistance (hours)	Nominal cover (mm)				
	Beams		Floors		Columns
	Simply supported	Continuous	Simply supported	Continuous	
0.5	20	20	20	20	20
1.0	20	20	20	20	20
1.5	20	20	25	20	20
2.0	40	30	35	25	25
3.0	60	40	45	35	25
4.0	70	50	55	45	25

Table 2 Cross-sectional areas of groups of bars (mm^2)

Bar size (mm)	Number of bars									
	1	2	3	4	5	6	7	8	9	10
6	28.3	56.6	84.9	113	142	170	198	226	255	283
8	50.3	101	151	201	252	302	352	402	453	503
10	78.5	157	236	314	393	471	550	628	707	785
12	113	226	339	452	566	679	792	905	1020	1130
16	201	402	603	804	1010	1210	1410	1610	1810	2010
20	314	628	943	1260	1570	1890	2200	2510	2830	3140
25	491	982	1470	1960	2450	2950	3440	3930	4420	4910
32	804	1610	2410	3220	4020	4830	5630	6430	7240	8040
40	1260	2510	3770	5030	6280	7540	8800	10100	11300	12600

Table 6 Basic span /effective depth ratio for rectangular or flanged beams (Table 3.9, BS 8110)

Support conditions	*Rectangular sections*	*Flanged beams with* $\frac{\text{width of beam}}{\text{width of flange}} \leq 0.3$
Cantilever	7	5.6
Simply supported	20	16.0
Continuous	26	20.8

Table 7 Modification factors for compression reinforcement (Table 3.11, BS 8110)

$100\frac{A'_{s\,prov}}{bd}$	Factor
0.00	1.00
0.15	1.05
0.25	1.08
0.35	1.10
0.50	1.14
0.75	1.20
1.0	1.25
1.5	1.33
2.0	1.40
2.5	1.45
$\geq$ 3.0	1.50

NOTE 1 The values in this table are derived from the following equation:
Modification factor for compression reinforcement =

$$1 + \frac{100A'_{s\,prov}}{bd} \Big/ \left(3 + \frac{100A'_{s\,prov}}{bd}\right) \leq 1.5$$ equation 9

NOTE 2 The area of compression reinforcement A used in this table may include all bars in the compression zone, even those not effectively tied with links.

Table 3 Values of design concrete shear stress, υ_c (N/mm^2) for f_{cu} = 25 N/mm^2 concrete (Table 3.8, BS 8110)

$\frac{100A_s}{bd}$	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	0.57	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

NB: For other values of cube strength up to a maximum of 40 Nmm^{-2}, the design shear stresses can be determined by multiplying the values in the table by the factor $\sqrt{}(f_{cu}/25)^{1/3}$.

Table 4 Form and area of links in beams (Table 3.7, BS 8110)

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

Table 5 Values of A_{sv}/s_v

Diameter (mm)	*Spacing of links (mm)*										
	85	90	100	125	150	175	200	225	250	275	3
8	1.183	1.118	1.006	0.805	0.671	0.575	0.503	0.447	0.402	0.366	0.
10	1.847	1.744	1.57	1.256	1.047	0.897	0.785	0.698	0.628	0.571	0.
12	2.659	2.511	2.26	1.808	1.507	1.291	1.13	1.004	0.904	0.822	0.
16	4.729	4.467	4.02	3.216	2.68	2.297	2.01	1.787	1.608	1.462	1.

Table 7 Modification factors for tension reinforcement (based on Table 3.10, BS 8110)

Service stress	M/bd^2							
	0.50	*0.75*	*1.00*	*1.50*	*2.00*	*3.00*	*4.00*	*5.00*
100	2.00	2.00	2.00	1.86	1.63	1.36	1.19	1.08
150	2.00	2.00	1.98	1.69	1.49	1.25	1.11	1.01
($f_y = 250$) 167	2.00	2.00	1.91	1.63	1.44	1.21	1.08	0.99
200	2.00	1.95	1.76	1.51	1.35	1.14	1.02	0.94
250	1.90	1.70	1.55	1.34	1.20	1.04	0.94	0.87
300	1.60	1.44	1.33	1.16	1.06	0.93	0.85	0.80
($f_y = 500$) 323	1.41	1.28	1.18	1.05	0.96	0.86	0.79	0.75

Note 1. The values in the table derive from the equation:

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

where
f_s is the design service stress in the tension reinforcement
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 may be estimated from the equation:

$$f_s = \frac{5^*}{8} \times \frac{f_y A_{s,req}}{A_{s,prov}} \times \frac{1}{\beta_b} \quad \text{(equation 8)}$$

where β_b is the percentage of moment redistribution, equal to 1 for simply supported beams.
* As pointed out in Reynolds RC Designers Handbook the term 5/8 which is applicable to $\gamma_{ms} = 1.15$ is given incorrectly as in BS 8110 which is applicable to $\gamma_{ms} = 1.05$.

Table 8 Cross-sectional area per metre width for various bar spacing (mm^2)

Bar size (mm)	*Spacing of bars*								
	50	*75*	*100*	*125*	*150*	*175*	*200*	*250*	*30*
6	566	377	283	226	189	162	142	113	9
8	1010	671	503	402	335	287	252	201	16
10	1570	1050	785	628	523	449	393	314	26
12	2260	1510	1130	905	754	646	566	452	37
16	4020	2680	2010	1610	1340	1150	1010	804	67
20	6280	4190	3140	2510	2090	1800	1570	1260	105
25	9820	6550	4910	3930	3270	2810	2450	1960	164
32	16100	10700	8040	6430	5360	4600	4020	3220	268
40	25100	16800	12600	10100	8380	7180	6280	5030	419