Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2016/2017

COURSE NAME	:	STRUCTURAL DESIGN
COURSE CODE	:	BPD 30802
PROGRAMME CODE	:	BPC
EXAMINATION DATE	:	DECEMBER 2016 / JANUARY 2017
DURATION	:	2 HOURS
INSTRUCTION	:	ANSWERS **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **SIX (6)** PAGES

Q1 (a) Explain the aim of designing an under-reinforced concrete structural component.

(4 marks)

(b) Describe the the behaviour of a loaded continuous beam in bending.

(6 marks)

(c) A rectangular reinforced concrete beam has to support a design moment of 200kNm. The beam rectangular section dimension is 300 x 500 mm (b x d) as shown in Figure **Q1**. Characteristic concrete strength of beam, f_{ck} = 25N/mm^2; and high yield steel reinforcement characteristic strength, f_{yk} = 500N/mm^2.

Calculate the area of steel reinforcement required.

(15marks)

Q2 (a) Describe the two principle types of Limit State Design.

(8 marks)

(b) State the **FOUR (4)** conditions that are required to achieve durability of reinforced concrete structures according to Eurocode 2: Design of concrete structures-Part 1-1: General rules and rules for buildings.

(4 marks)

(c) A rectangular reinforced concrete beam has to support a design moment of 300kNm. Determine the area of reinforcement required if the beam dimension is 250 x 500 mm (b x d), concrete strength, f_{ck} = 25 N/mm^2 and steel strength f_{yk} = 500 N/mm^2.

(13 marks)

Q3 (a) Describe with the aid of sketches, the effective length of steel columns due to different types of end restraints.

(5 marks)

(b) Illustrate with explanation **TWO (2)** methods used for prestressing of concrete members.

(8 marks)

(b) A UC section member is to be used as an internal column in a multi-storey building. The column has pinned boundary conditions at each end, and the inter-storey height is 4.5 m. The critical combination of actions results in a design axial force of 305.6 kN. The cross-section is Class 1 under pure compression and for minor axis buckling curve c gives value of α = 0.49 with cross-section resistance, $N_{c,Rd}$ = 1053 kN and minor axis elastic critical buckling force, $N_{cr,z}$ = 573.2 kN.

Calculate the suitability of a 152x152x30 UC in grade S 275 steel for this application in terms of being a compression member that has suitable buckling resistance. The section properties are shown in Figure **Q3**.

(12 marks)

Q4 (a) A flat slab floor is a reinforced concrete slab supported directly by concrete columns without the use of intermediary beams.

(i) Describe with the aid of sketches describe the purpose of providing column heads and drop panels.

(6 marks)

(ii) Discuss the advantage of the flat slab floor over the beam and slab floor.

(4 marks)

(b) A rectangular reinforced concrete slab is simply supported on two masonry walls 250mm thick and 5m apart (clear distance) as shown in Figure **Q3**. The slab carries a distributed permanent action of 1.5 kN/m^2 (excluding slab self-weight) and a variable action of 2.0 kN/m^2. Characteristic concrete strength of slab, f_{ck} = $30N/mm^2$, the high yield steel reinforcement characteristic strength, $f_{yk} = 500N/mm^2$, and unit weight of reinforced concrete is $25kN/m^3$. The diameter of steel reinforcement bar = 12mm with slab thickness, h = 175mm and nominal concrete cover for durability, fire and bond requirements being 30mm.

(i) Sketch the shear and bending moment diagrams for the one-way concrete slab, indicating the maximum shear force and bending moment values.

(6 marks)

(ii) Calculate the area of steel reinforcement required in the design of this one - way spanning slab without having to verify for shear, deflection and cracking.

(9 marks)

- END OF QUESTIONS -

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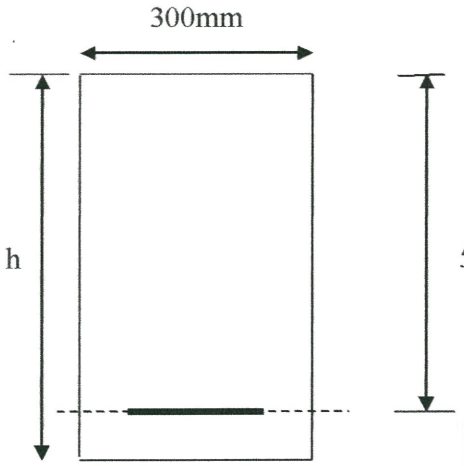
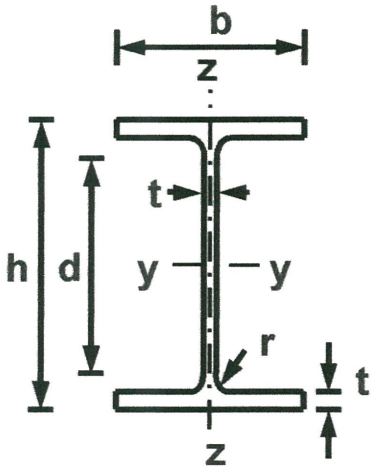


FIGURE Q1



h = 157.6 mm
b = 152.9 mm
t_w = 6.5 mm
t_f = 9.4 mm
r = 7.6 mm
A = 3830 mm^2
I_y = 17480000 mm^4
I_z = 5600000 mm^4

Section properties for 152x152x30 UC

FIGURE Q3

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$g_k = 1.5$ kN/m^2 (excluding s/w)
$q_k = 2.0$ kN/m^2

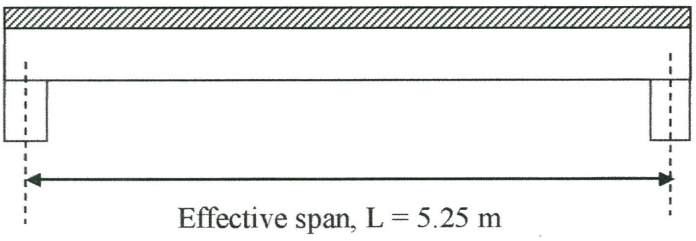

FIGURE Q4

Cross Sectional Area of Reinforcement

Table 1: Cross Sectional Area (mm^2) according to Size and Numbers of Bar

Bar Size (mm)	Number of bar								Perimeter (mm)
	1	2	3	4	5	6	7	8	
6	28.3	56.6	84.9	113	141	170	198	226	18.9
8	50.3	101	151	201	251	302	352	402	25.1
10	78.6	157	236	314	393	471	550	629	31.4
12	113	226	339	453	566	679	792	905	37.7
16	201	402	603	805	1006	1207	1408	1609	50.3
20	314	629	943	1257	1571	1886	2200	2514	62.9
25	491	982	1473	1964	2455	2946	3438	3929	78.6
32	805	1609	2414	3218	4023	4827	5632	6437	100.6
40	1257	2514	3771	5029	6286	7543	8800	10057	125.7

Table 2: Cross Sectional Area (mm^2) for every meter width at distance between bar

Bar Size (mm)	Distance between Bar (mm)								
	50	75	100	125	150	175	200	250	300
6	566	377	283	226	189	162	141	113	94
8	1006	670	503	402	335	287	251	201	168
10	1571	1048	786	629	524	449	393	314	262
12	2263	1509	1131	905	754	647	566	453	377
16	4023	2682	2011	1609	1341	1149	1006	805	670
20	6286	4190	3143	2514	2095	1796	1571	1257	1048
25	9821	6548	4911	3929	3274	2806	2455	1964	1637
32	16091	10728	8046	6437	5364	4598	4023	3218	2682
40	25143	16762	12571	10057	8381	7184	6286	5029	4190