Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2015/2016

COURSE NAME	:	STRUCTURAL DESIGN
COURSE CODE	:	BPD 30802
PROGRAMME	:	3 BPC
EXAMINATION DATE	:	DECEMBER 2015/JANUARY 2016
DURATION	:	2 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **SEVEN (7)** PAGES

Q1 (a) Discuss the purpose of structural design during the design phase.

(9 marks)

(b) Figure **Q1** shows a simply supported rectangular reinforced concrete slab carries a distributed permanent action of 1.5 kN/m^2 (excluding selfweight) and a variable action of 2.5 kN/m^2. Given the characteristic strength of concrete, f_{ck} = 30 N/mm^2, the characteristic strength of steel, f_{yk} = 500 N/mm^2 and unit weight of concrete 25 kN/mm^3. The nominal concrete cover is 30 mm, the slab thickness, h is 175 mm and the steel reinforcing bar is 10 mm.

Calculate the area of reinforcement required for the slab and perform the shear and deflection checks.

(16 marks)

Q2 (a) Explain with aid of sketches, the singly reinforced section with rectangular stress block.

(9 marks)

(b) Figure **Q2** shows a rectangular RC beam with the size of 200 X 500 mm (b x d). The beam has to support a design moment of 180 kNm. Given the characteristic strength of concrete, f_{ck} = 25 N/mm^2 and the characteristic strength of main reinforcement, f_{yk} = 500 N/mm^2.

Calculate the area of reinforcement required for the beam.

(16 marks)

Q3 (a) Explain the following topics:

(i) Local buckling of steel structures.
(ii) Lateral torsional buckling of steel structures.
(iii) Stress-strain relations of steel structures.

(9 marks)

(b) A simply supported steel beam is fully restrained along its length as shown in Figure **Q3**. The beam supports uniformly distributed characteristic dead and imposed loads of 3 kN/m each, as well as a characteristic imposed point load of 10 kN at mid span. Use the given data as follow:

Beam size	= 406 X 178 X 60 kg/m UB S275
Beam length	= 8 m
Modulus of elasticity (E)	= 205 x 10^6 kN/m^2

(i) Calculate the maximum applied bending moment, M_c.

(4 marks)

(ii) Sketch the shear force and bending moment diagrams.

(2 marks)

(iii) Calculate the shear and moment capacity.

(10 marks)

Q4 (a) Explain with aid of sketches, the failure modes of slender and non-slender column.

(5 marks)

(b) Figure **Q4** shows a cross-section of a rectangular braced column of 220 mm X 300 mm. The column is classified as short column and subjected to ultimate load of 1250 kN. Given bending moments of 55 kNm and 30 kNm about major and minor axes respectively. Use the characteristic strength of concrete, f_{ck} = 25 N/mm^2, the characteristic strength of steel, f_{yk} = 500 N/mm^2, C_{nom} = 30 mm, the effective length = 4.2 m, ϕ_{link} = 6 mm and ϕ_{bar} = 20 mm.

(i) Calculate the value of M_{min} and M_{Ed}.

(8 marks)

(ii) Design the main reinforcement of the column.

(12 marks)

- END OF QUESTIONS –

FINAL EXAMINATION

SEMESTER/SESSION: SEM I/2015/2016 PROGRAMME : 3 BPC
COURSE NAME : STRUCTURAL DESIGN COURSE CODE: BPD 30802

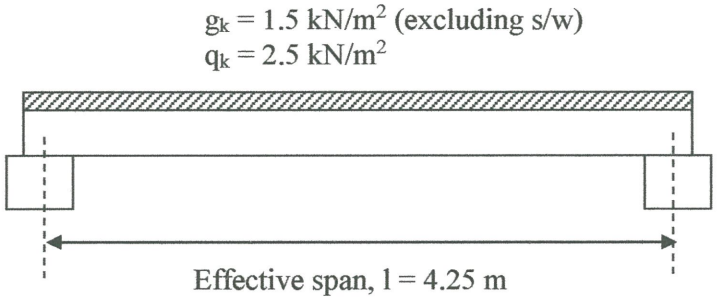

FIGURE Q1: A simply supported rectangular RC slab

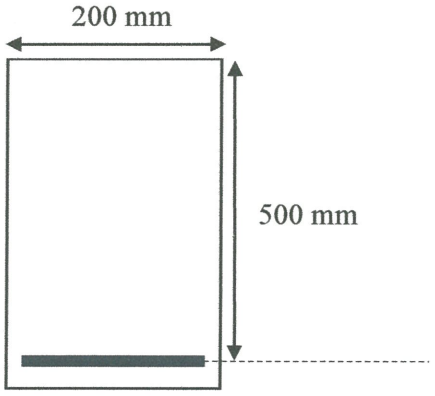

FIGURE Q2: Cross-section of a simply supported rectangular RC beam

FINAL EXAMINATION

SEMESTER/SESSION: SEM I/2015/2016 PROGRAMME : 3 BPC
COURSE NAME : STRUCTURAL DESIGN COURSE CODE: BPD 30802

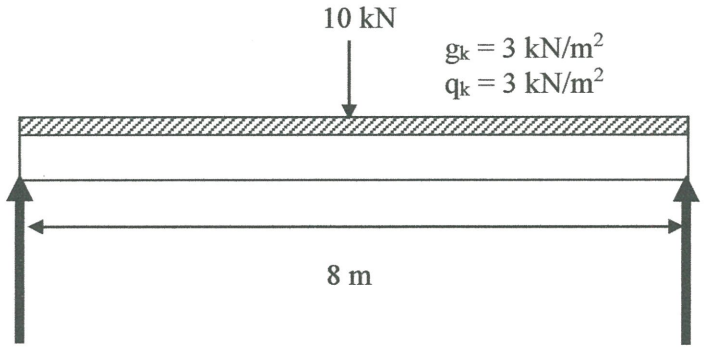

FIGURE Q3: A simply supported steel beam

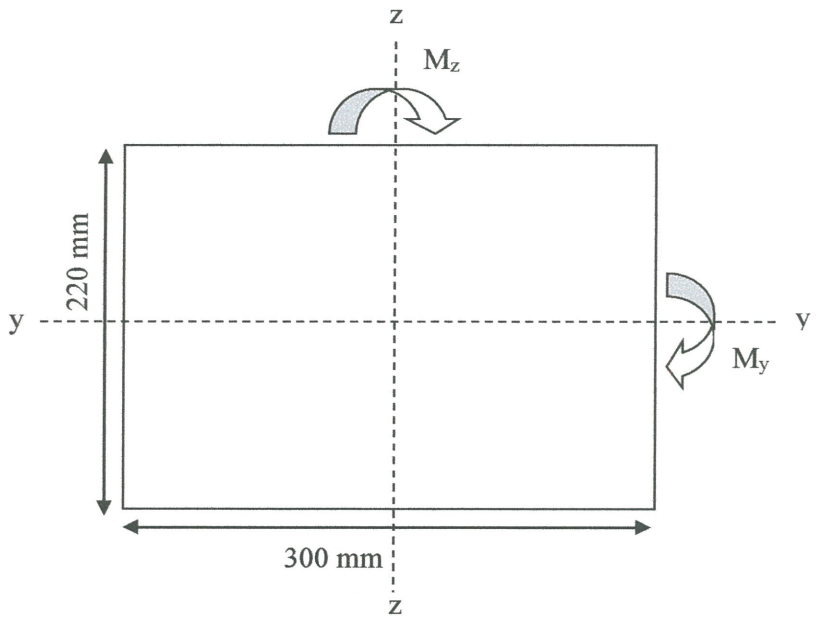

FIGURE Q4: Cross-section of a rectangular braced column

FINAL EXAMINATION

SEMESTER/SESSION: SEM I/2015/2016 PROGRAMME : 3 BPC
COURSE NAME : STRUCTURAL DESIGN COURSE CODE: BPD 30802

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

FINAL EXAMINATION

SEMESTER/SESSION: SEM I/2015/2016 PROGRAMME : 3 BPC
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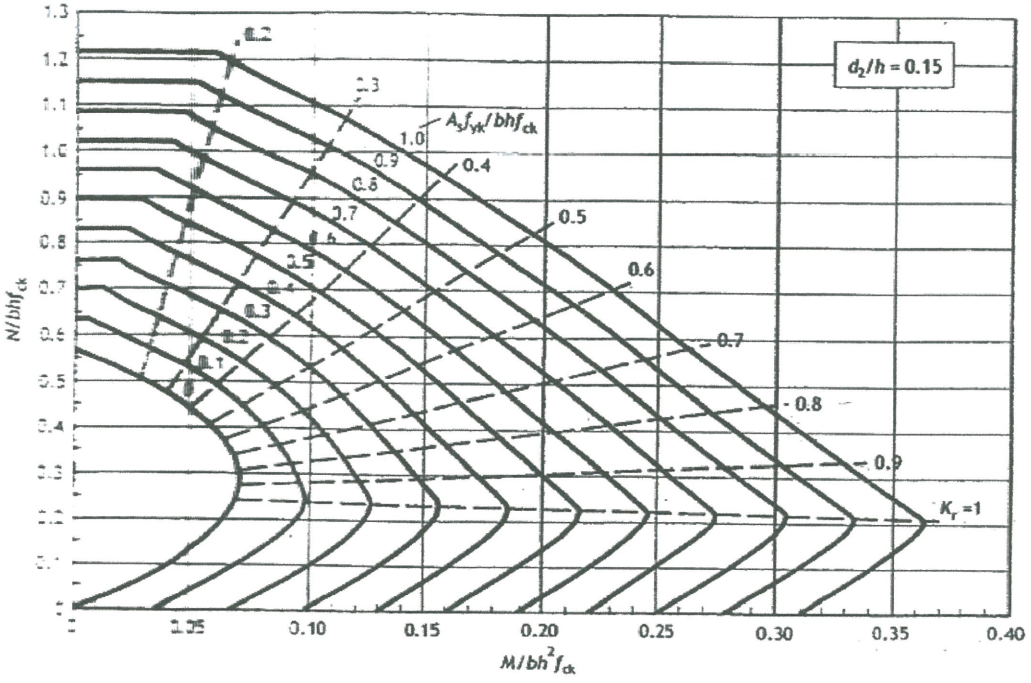
Given :

1. $M_{bal} = 0.167 f_{ck} bd^2$
2. $K = M / bd^2 f_{ck}$
3. $z = d\{0.5 + \sqrt{0.25 - k/1.134}\}$
4. $A_s = M / 0.87 f_{yk} z$



Column design chart