Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2014/2015

COURSE NAME	:	STRUCTURAL DESIGN
COURSE CODE	:	BPD 30802
PROGRAMME	:	3 BPC
EXAMINATION DATE	:	DECEMBER 2014/JANUARY 2015
DURATION	:	2 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **EIGHT (8)** PAGES

Q1 (a) Describe **TWO (2)** principal types of reinforced concrete foundations for buildings.

(6 marks)

(b) Depending on the amount of reinforcing steel provided, flexural failure may occur in three ways based on the three types of sections: balanced, under-reinforced and over-reinforced sections in bending.

Explain with the aid of sketches, **THREE (3)** modes of flexural failure.

(12 marks)

(c) Calculate the ultimate moment capacity of a reinforced concrete beam that measures 300 x 500 mm (b x d), if concrete strength f_{ck} = 25 N/mm^2 and steel strength f_{yk} = 500 N/mm^2 and the tension reinforcement provided is 3H20.

(7 marks)

Q2 (a) The three elements of the retaining wall, i.e. stem, toe slab and heel are designed as cantilever slabs to resist design moments and shear forces.

Explain the design considerations for these three elements.

(6 marks)

(b) Describe with the aid of sketches the the overturning mode of failure of a vertical cantilever retaining wall.

(7 marks)

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

(12 marks)

Q3 (a) Describe the **FOUR (4)** methods of design in the use of Limit State Design of Structural Steelwork.

(8 marks)

(b) The objective of design is to keep an acceptable level of probability that any limit state will not be exceeded, otherwise failure of the particular member will occur.

Explain the main failure modes of hot rolled steel beams.

(9 marks)

(c) In the design of a protal frame structure, a 254 x 254 x 73 UC is in pure compression. Assume that grade S355 steel is used and based on additional information provided in APPENDIX I, II and III;

(i) Distinguish the classification of the steel column.

(4 marks)

(ii) Calculate the resistance $N_{c,Rd}$ for the universal steel column.

(4 marks)

Q4 A rectangular reinforced concrete slab is simply supported on two masonry walls 250mm thick and 4m apart (clear distance). The slab carries a distributed permanent action of 1.0 kN/m^2 (excluding slab self-weight) and a variable action of 3.0 kN/m^2. Based on further slab information in Table **Q4**:

(a) Analyze the area of steel reinforcement required in the design of this one-way spanning slab without having to verify for deflection. Nominal cover for durability, fire and bond requirements are required to be 30mm.

(17 marks)

(b) Calculate the design shear resistance, $V_{Rd,c}$.

(6 marks)

(c) Determine if cracking considerations are satisfied.

(2 marks)

- END OF QUESTION -

APPENDIX I

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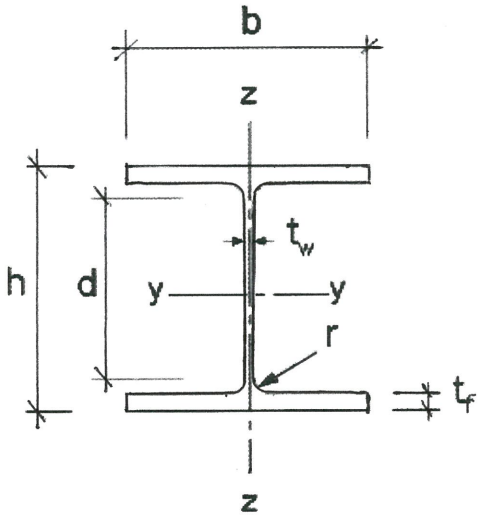

FIGURE Q3

h = 254.1mm
b = 254.6 mm
t_w = 8.6mm
t_f = 14.2mm
r = 12.7mm
A = 9310mm^2

TABLE Q3 (i)

APPENDIX II

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Cross-section Classification

Class 1: Plastic

		BS (Table 11)	EC3 (Table 5.2)
Limits	Flange outstand	b/T = < 9 ε	c/t_f = < 9 ε
	Web in bending	d/t = < 80 ε	d/t_w = < 72 ε
	Web in compression		d/t_w = < 33 ε

Class 2: Compact

		BS (Table 11)	EC3 (Table 5.2)
Limits	Flange outstand	b/T = < 10 ε	c/t_f = < 10 ε
	Web in bending	d/t = < 100 ε	d/t_w = < 83 ε
	Web in compression		d/t_w = < 38 ε

TABLE Q3 (ii)

APPENDIX III

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Class 3: Semi-compact

		BS (Table 11)	EC3 (Table 5.2)
Limits	Flange outstand	b/T = < 15 ε	c/t_f = < 14 ε
	Web in bending	d/t = < 120 ε	d/t_w = < 142 ε
	Web in compression		d/t_w = < 42 ε

Width to thickness ratio

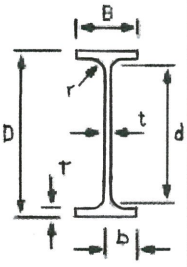
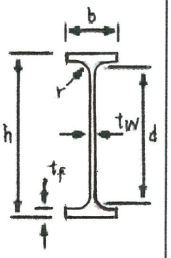
	BS 5950	EC3
		
Outstand Flange	b = B/2	c = (b – t_w – 2 r)/2
Internal Compression Part	d = D – 2 T – 2 r	c = h – 2 t_f – 2 r

TABLE Q3 (iii)

APPENDIX IV

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f_{ck}	$30N/mm^2$
f_{yk}	$500N/mm^2$
concrete unit weight	$25kN/m^3$
ϕ	12mm
h	175mm

TABLE Q4

APPENDIX V

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Cross Sectional Area of Reinforcement

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

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