UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2013/2014

COURSE NAME	:	STRUCTURE ANALYSIS & DESIGN
COURSE CODE	:	BNP 20803
PROGRAMME	:	BNB
EXAMINATION DATE	:	JUNE 2014
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS
		DESIGN SHOULD BE BASED ON:
		BS EN 1990:2002+A1 2005 NA BS EN 1990:2002+A1:2005 BS EN 1991-1-1:2002 NA BS EN 1991-1-1:2002 BS EN 1992-1-1:2004 BS 8110:PART 1:1997 BS EN 1993 :2005

THIS QUESTIONS PAPER CONSISTS OF **FIFTEEN (15)** PAGES

ENGLISH

Q1 One continous beam has supported uniformly distributed load 20 kN/m and point load 60 kN as shown in Figure **Q1.** Given Modulus of Elasticity, E = 70 GPa and I = 800 x 10^6 mm^4

(a) Calculate the moment at the joints by using moment distribution method. Conduct **FOUR (4)** rotations for moment distribution.

(12 marks)

(b) Determine the support reaction.

(5 marks)

(c) Draw the shear force diagram

(4 marks)

(d) Draw the bending moment diagram.

(4 marks)

Q2 Figure **Q2** shows the plan view of slab-beam system in one building. Due to construction works, beam and a part of the slab has to act as a pre-cast concrete slab. Given;

Slab thickness	=	150 mm
Beam size	=	250 mm x 500 mm
Finishes	=	1.0 kN/m^2
Ceiling	=	1.0 kN/m^2
Brickwall (3.0 m height)	=	2.6 kN/m^2

Chac. variable action, q_k	=	3.0 kN/m^2
Chac. strength of concrete, f_{ck}	=	30 N/mm^2
Chac. strength of steel, f_{yk}	=	500 N/mm^2

(a) Sketch the action distribution on the beam from each slab.

(2 marks)

(b) Referring to the simply supported beam B/1-2;

(i) Determine the design action act on beam.

(10 marks)

(ii) Determine the maximum shear force and bending moment.

(3 marks)

(iii) Design the area of tension reinforcement (A_s) and classify either the section is under or over reinforced. Assume diameter of reinforcement 20 mm and effective depth is 460 mm.

(10 marks)

Q3 (a) List the assumptions that have been made in design reinforced concrete beam.

(5 marks)

(b) Figure **Q3** shows an architectural drawing of first floor plan for 3 storey building. Detail specification is given as follows:

Design action, w	=	30.46 kN/m
Characteristic strength of concrete, f_{ck}	=	20 N/mm^2
Characteristic strength of steel bar, f_{yk}	=	500 N/mm^2
Concrete cover, c	=	25 mm

(i) Propose and sketch the structural layout plan.

(3 marks)

(ii) From the specification, provide the suitable size for beam 1/A-C.

(2 marks)

(iii) Design the main reinforcement for simply supported beam 1/A-C. Please state your assumption in design.

(8 marks)

(iv) Design shears reinforcement for beam 1/A-C.

(7 marks)

Q4 (a) Steel is an alloy made by combining iron and other elements. The most common of these is being carbon. List the stages and briefly explain of steel production.

(7 marks)

(b) Classify the cross-section of a 533 x 210 x 92UB grade S275 as shown in Figure **Q4** . The section is subjected to bending moment at a major axis (y-y) and axial force of 300 kN.

(18 marks)

- END OF QUESTION -

BAHASA MELAYU

S1 Satu rasuk selanjar menyokong beban tergaih seragam 20 kN/m dan beban tumpu 60 kN seperti Rajah **Q1**. Diberi Modulus Keanjalan, E = E = 70 GPa dan I = 800 x 10^6 mm^4.

(a) Kirakan momen pada sambungan dengan menggunakan kaedah agihan momen. Lakukan **EMPAT (4)** pusingan agihan momen.

(12 markah)

(b) Tentukan tindakbalas penyokong.

(5 markah)

(c) Lukiskan gambarajah daya ricih.

(4 markah)

(d) Lukiskan gambarajah momen lentur.

(4 markah)

S2 Rajah **Q2** menunjukkan pelan pandangan bagi sistem lantai-rasuk dalam satu bangunan. Berdasarkan kerja-kerja pembinaan, rasuk dan sebahagian lantai bertindak sebagai lantai pra-tuang konkrit.

Diberi;

Ketebalan lantai	=	150 mm
Saiz Rasuk	=	250 mm x 500 mm
Kemasan	=	1.0 kN/m^2
Siling	=	1.0 kN/m^2
Dinding Bata (3.0 m tinggi)	=	2.6 kN/m^2

Beban Ciri Variasi, q_k	=	3.0 kN/m^2
Gred Konkrit, f_{ck}	=	30 N/mm^2
Gred Tetulang Keluli, f_{yk}	=	500 N/mm^2

(a) Lakarkan agihan beban dari rasuk kepada setiap lantai.

(2 markah)

(b) Berdasarkan kepada rasuk penyokong mudah B/1-2;

(i) Tentukan beban rekabentuk yang bertindak pada rasuk.

(10 markah)

(ii) Tentukan daya ricih dan momen lentur maksimum.

(3 markah)

(iii) Rekabentuk untuk luas tetulang keluli tegangan (A_s) dan kelaskan samada seksyen tersebut adalah di bawah atau di atas rekabentuk tetulang. Anggapkan diameter tetulang adalah 20 mm dan tinggi efektif adalah 460 mm.

(10 markah)

S3 (a) Senaraikan anggapan yang dibuat dalam merekabentuk rasuk bertetulang.

(5 markah)

(b) Rajah **Q3** menunjukkan pelan bangunan tiga tingkat. Spesifikasi bagi bangunan adalah seperti berikut:

Beban rekabentuk ,w	=	30.46 N/m
Kekuatuan ciri konkrit, f_{ck}	=	20 N/mm^2
Kekuatan ciri tetulang keluli,f_{yk}	=	500 N/mm^2
Penutup konkrit, c	=	25 mm

(i) Cadang dan lakarkan susun atur pelan struktur.

(3 markah)

(ii) Daripada spesifikasi yang diberikan, tentukan saiz bagi rasuk 1/A-C.

(2 markah)

(iii) Rekabentuk tetulang utama untuk rasuk disokong mudah 1/A-C.Sila nyatakan anggapan anda.

(8 markah)

(v) Rekabentuk tetulang ricih untuk 1/A-C.

(7 markah)

S4 (a) Keluli adalah aloi yang dibuat dari gabungan besi dan elemen lain dan yang sangat popular adalah karbon. Senaraikan peringkat dan terangkan secara ringkas untuk penghasilan keluli.

(7 markah)

(b) Kelaskan keratan rentas bagi 533 x 210 x 92UB gred S275 seperti ditunjukkan Rajah **Q4** . Keratan ini adalah bagi momen lentur pada paksi major (y-y) dan daya beban paksi adalah 300 kN.

(18 markah)

-SOALAN TAMAT-

FINAL EXAMINATION

SEMESTER/SESI: SEM II/2013/2014
COURSE NAME: STRUCTURE ANALYSIS & DESIGN

PROGRAMME: BNB
COURSE CODE: BNP 20803

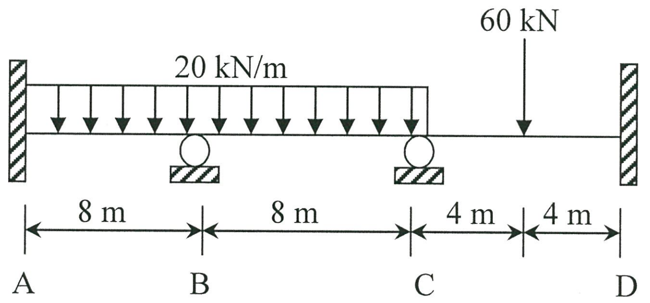


FIGURE Q1

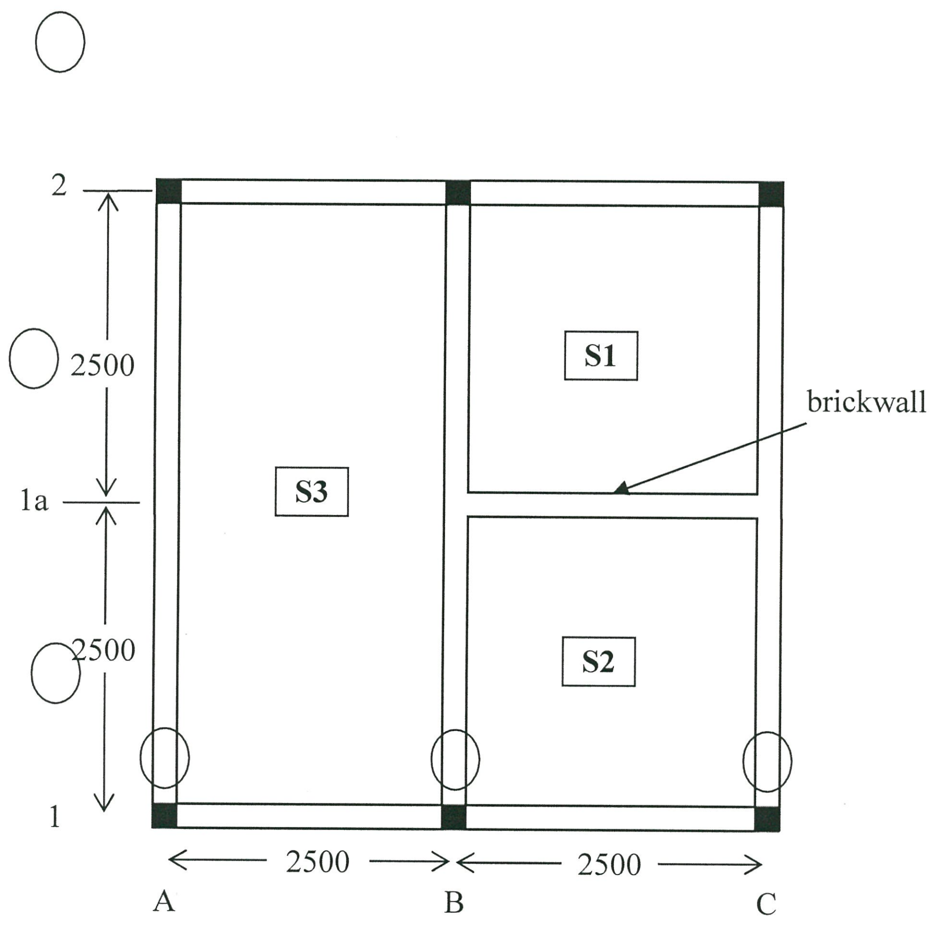


FIGURE Q2

FINAL EXAMINATION

SEMESTER/SESI: SEM II/2013/2014 PROGRAMME: BNB
COURSE NAME: STRUCTURE ANALYSIS & DESIGN COURSE CODE: BNP 20803

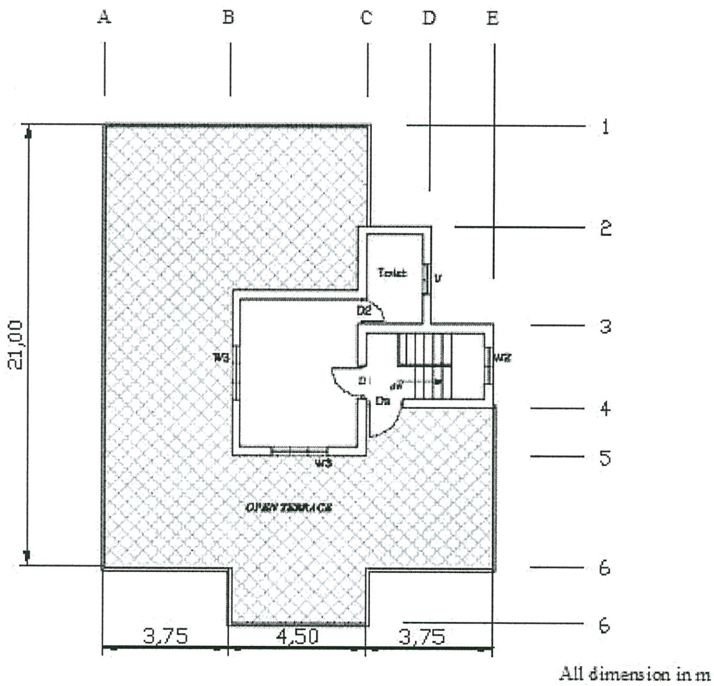
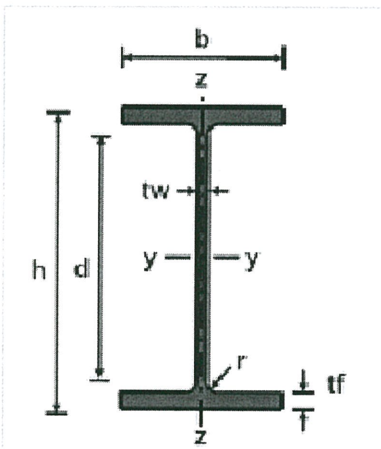


FIGURE Q3



$h = 533.1$ mm
$b = 209.3$ mm
$t_w = 10.1$ mm
$t_f = 15.6$ mm
$r = 12.7$ mm
$A = 117$ cm^2

FIGURE Q4

FINAL EXAMINATION

SEMESTER/SESI: SEM II/2013/2014 PROGRAMME: BNB
COURSE NAME: STRUCTURE ANALYSIS & DESIGN COURSE CODE: BNP 20803

APPENDIX

Table 3.15 – Shear force coefficient for uniformly loaded rectangular panels supported on four sides with provision for torsion at corners (Source: BS 8110-1: 1997)

Type of panel location	β_{vx} for values of l_y/l_x								β_{vy}
	1.0	1.1	1.2	1.3	1.4	1.5	1.75	2.0	
One long edge discontinuous									
Continuous edge	0.36	0.40	0.44	0.47	0.49	0.51	0.55	0.59	0.36
Discontinuous edge	0.24	0.27	0.29	0.31	0.32	0.34	0.36	0.38	-
Two adjacent edges discontinuous									
Continuous edge	0.40	0.44	0.47	0.50	0.52	0.54	0.57	0.60	0.40
Discontinuous edge	0.26	0.29	0.31	0.32	0.34	0.35	0.38	0.40	0.26
Three edges discontinuous (one long edge continuous)									
Continuous edge	0.45	0.48	0.51	0.53	0.55	0.57	0.60	0.63	-
Discontinuous edge	0.30	0.32	0.34	0.35	0.36	0.37	0.39	0.41	0.29
Three edges discontinuous (one short edge continuous)									
Continuous edge	-	-	-	-	-	-	-	-	0.45
Discontinuous edge	0.29	0.33	0.36	0.38	0.40	0.42	0.45	0.48	0.30

FINAL EXAMINATION

SEMESTER/SESI: SEM II/2013/2014 PROGRAMME: BNB
COURSE NAME: STRUCTURE ANALYSIS & DESIGN COURSE CODE: BNP 20803

APPENDIX

Table 3.1 (continued): Nominal values of yield strength f_y and ultimate tensile strength f_u for structural hollow sections

Standard and steel grade	Nominal thickness of the element t [mm]			
	$t \leq 40$ mm		40 mm $< t \leq 80$ mm	
	f_y [N/mm^2]	f_u [N/mm^2]	f_y [N/mm^2]	f_u [N/mm^2]
EN 10210-1				
S 235 H	235	360	215	340
S 275 H	275	430	255	410
S 355 H	355	510	335	490
S 275 NH/NLH	275	390	255	370
S 355 NH/NLH	355	490	335	470
S 420 NH/NHL	420	540	390	520
S 460 NH/NLH	460	560	430	550
EN 10219-1				
S 235 H	235	360		
S 275 H	275	430		
S 355 H	355	510		
S 275 NH/NLH	275	370		
S 355 NH/NLH	355	470		
S 460 NH/NLH	460	550		
S 275 MH/MLH	275	360		
S 355 MH/MLH	355	470		
S 420 MH/MLH	420	500		
S 460 MH/MLH	460	530		

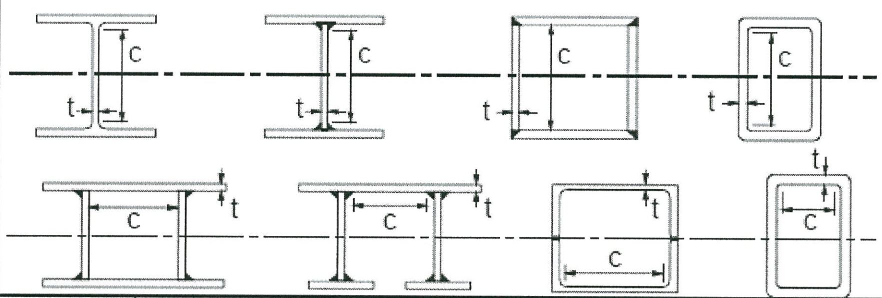
FINAL EXAMINATION

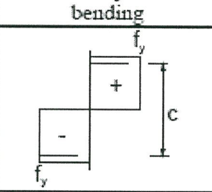
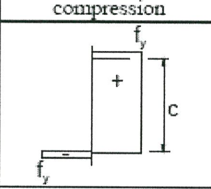
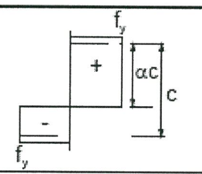
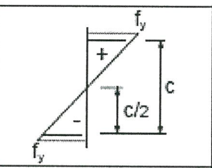
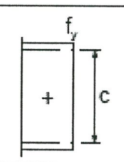
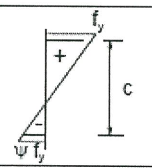
SEMESTER/SESI: SEM II/2013/2014 PROGRAMME: BNB
COURSE NAME: STRUCTURE ANALYSIS & DESIGN COURSE CODE: BNP 20803

APPENDIX

Table 5.2 (sheet 1 of 3): Maximum width-to-thickness ratios for compression parts

Internal compression parts



Class	Part subject to bending	Part subject to compression	Part subject to bending and compression
Stress distribution in parts (compression positive)			
1	$c/t \le 72\varepsilon$	$c/t \le 33\varepsilon$	when $\alpha > 0{,}5$: $c/t \le \dfrac{396\varepsilon}{13\alpha - 1}$ when $\alpha \le 0{,}5$: $c/t \le \dfrac{36\varepsilon}{\alpha}$
2	$c/t \le 83\varepsilon$	$c/t \le 38\varepsilon$	when $\alpha > 0{,}5$: $c/t \le \dfrac{456\varepsilon}{13\alpha - 1}$ when $\alpha \le 0{,}5$: $c/t \le \dfrac{41{,}5\varepsilon}{\alpha}$
Stress distribution in parts (compression positive)			
3	$c/t \le 124\varepsilon$	$c/t \le 42\varepsilon$	when $\psi > -1$: $c/t \le \dfrac{42\varepsilon}{0{,}67 + 0{,}33\psi}$ when $\psi \le -1^{*)}$: $c/t \le 62\varepsilon(1-\psi)\sqrt{(-\psi)}$

$\varepsilon = \sqrt{235/f_y}$	f_y	235	275	355	420	460
	ε	1,00	0,92	0,81	0,75	0,71

*) $\psi \le -1$ applies where either the compression stress $\sigma \le f_y$ or the tensile strain $\varepsilon_y > f_y/E$

FINAL EXAMINATION

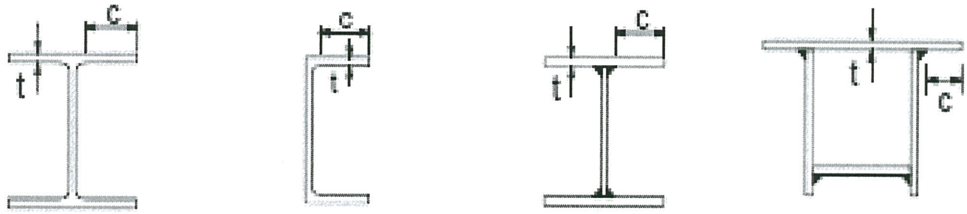
SEMESTER/SESI: SEM II/2013/2014 PROGRAMME: BNB
COURSE NAME: STRUCTURE ANALYSIS & DESIGN COURSE CODE: BNP 20803

APPENDIX

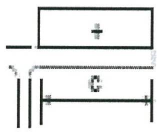
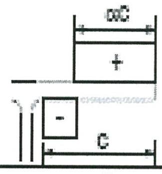
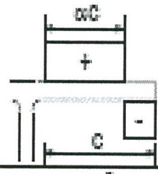
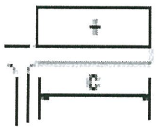
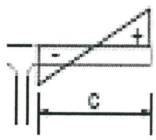
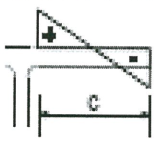
BS EN 1993-1-1:2005
EN 1993-1-1:2005 (E)

Table 5.2 (sheet 2 of 3): Maximum width-to-thickness ratios for compression parts

Outstand flanges



Rolled sections Welded sections

Class	Part subject to compression	Part subject to bending and compression: Tip in compression	Part subject to bending and compression: Tip in tension
Stress distribution in parts (compression positive)			
1	$c/t \le 9\varepsilon$	$c/t \le \dfrac{9\varepsilon}{\alpha}$	$c/t \le \dfrac{9\varepsilon}{\alpha\sqrt{\alpha}}$
2	$c/t \le 10\varepsilon$	$c/t \le \dfrac{10\varepsilon}{\alpha}$	$c/t \le \dfrac{10\varepsilon}{\alpha\sqrt{\alpha}}$
Stress distribution in parts (compression positive)			
3	$c/t \le 14\varepsilon$	$c/t \le 21\varepsilon\sqrt{k_\sigma}$ For k_σ see EN 1993-1-5	

$\varepsilon = \sqrt{235/f_y}$	f_y	235	275	355	420	460
	ε	1,00	0,92	0,81	0,75	0,71

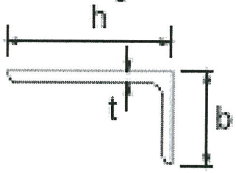
FINAL EXAMINATION

SEMESTER/SESI: SEM II/2013/2014 PROGRAMME: BNB
COURSE NAME: STRUCTURE ANALYSIS & DESIGN COURSE CODE: BNP 20803

APPENDIX

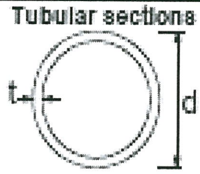
BS EN 1993-1-1:2005
EN 1993-1-1:2005 (E)

Table 5.2 (sheet 3 of 3): Maximum width-to-thickness ratios for compression parts

Refer also to "Outstand flanges" (see sheet 2 of 3)	Angles 	Does not apply to angles in continuous contact with other components

Class	Section in compression
Stress distribution across section (compression positive)	
3	(AC) $h/t \le 15\varepsilon$ and $\dfrac{b+h}{2t} \le 11{,}5\varepsilon$ (AC)

Tubular sections



Class	Section in bending and/or compression
1	$d/t \le 50\varepsilon^2$
2	$d/t \le 70\varepsilon^2$
3	$d/t \le 90\varepsilon^2$ NOTE For $d/t > 90\varepsilon^2$ see EN 1993-1-6.

$\varepsilon = \sqrt{235/f_y}$	f_y	235	275	355	420	460
	ε	1,00	0,92	0,81	0,75	0,71
	ε^2	1,00	0,85	0,66	0,56	0,51

FINAL EXAMINATION

SEMESTER/SESI: SEM II/2013/2014 PROGRAMME: BNB
COURSE NAME: STRUCTURE ANALYSIS & DESIGN COURSE CODE: BNP 20803

FORMULA

$$z = d[0.5 + \sqrt{0.25 - \frac{K_{bal}}{1.134}}$$

$$As' = \frac{(K - K_{bal}) f_{ck} bd^2}{0.87 f_{yk} (d - d')}$$

$$As = \frac{K_{bal} f_{ck} bd^2}{0.87 f_{yk} z_{bal}} + As'$$

$$V_{Rd,\max} = \frac{0.36 b_w d f_{ck} (1 - fck / 250)}{\cot\theta + \tan\theta}$$

$$\theta = 0.5 \sin^{-1}\left(\frac{V_{Ed}}{0.18 b_w d f_{ck} (1 - f_{ck} / 250)}\right)$$

$$\frac{A_{sw}}{s} = \frac{V_{Ed}}{0.78 f_{yk} d \cot\theta}$$

$$\frac{A_{sw\max}}{s} = \frac{0.08 f_{ck}^{1/2} b_w}{f_{yk}}$$

$$f_s = \frac{f_{yk}}{1.15}\left[\frac{G_k + 0.3 Q_k}{1.35 G_k + 1.5 Q_k}\right]\frac{1}{\delta}$$

FINAL EXAMINATION

SEMESTER/SESI: SEM II/2013/2014 PROGRAMME: BNB
COURSE NAME: STRUCTURE ANALYSIS & DESIGN COURSE CODE: BNP 20803

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