UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session 2006/2007

Oktober/November 2006

REG 365 – Concrete Structure
(Reka Bentuk Konkrit)

Duration: 3 hours
(Masa: 3 jam)

Please check that this examination paper consists of **NINE** pages of printed material before you begin the examination.

Sila pastikan bahawa kertas peperiksaan ini mengandungi **SEMBILAN** *muka surat yang bercetak sebelum anda memulakan peperiksaan ini.*

Students are allowed to answer all questions either in English OR in Bahasa Malaysia only

Pelajar dibenarkan menjawab semua soalan dalam Bahasa Inggeris ATAU Bahasa Malaysia sahaja.

Answer **FIVE** question only.

Jawab ***LIMA*** *soalan sahaja.*

...2/-

1. (a) Describe the advantages and disadvantages of reinforced concrete as a structural material.

   (b) What is code of practice and what is its purpose in structural design?

(20 marks/*markah*)

   (a) Huraikan tentang kebaikan dan keburukan konkrit bertetulang sebagai bahan struktur.

   (b) Apakah kod amalan dan apakah tujuanya di dalam rekabentuk struktur?

(20 marks/*markah*)

2. Explain what is meant by:-

   (a) Limit state design

   (b) Working stress method

   (c) Design loads acting on structures.

   (d) Unit weights of material

(20 marks/*markah*)

   Jelaskan apakah yang dimaksudkan dengan:-

   (a) Rekabentuk keadaan had

   (b) Kaedah tegasan kerja

   (c) Tindakan/Tindakbalas beban rekabentuk ke atas struktur

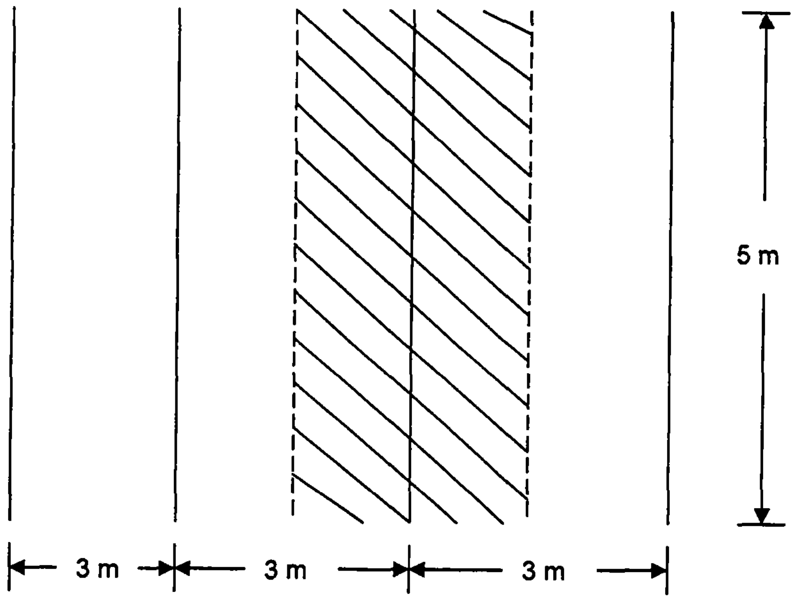
   (d) Berat unit bahan

(20 marks/*markah*)

...3/-

3. A composite floor consisting of a 150mm thick reinforced concrete slab supported on steel beams spanning 5m and spaced at 3m at the center is to be designed to carry an imposed load of 3.5 kNm^{-2} . Assuming that the unit mass of the steel beams is 50 kgm^{-1} , calculate the design loads on a typical internal beam.

Lantai komposit terdiri daripada papak konkrit bertetulang dengan ketebalan 150mm yang di sokong oleh rasuk keluli dengan rentangan 5m dan jarak ruang daripada bahagian tengah ialah 3m telah direkabentuk untuk menanggung beban kenaan sebanyak 3.5 kNm^{-2} . Andaikan jisim unit rasuk keluli ialah 50 kgm^{-1} , kirakan beban rekabentuk rasuk dalaman tipikal tersebut.



Unit mass of reinforced concrete is 2400 kgm^{-3}

The gravitational constant is 10 ms^{-2}

Dead load (g_k) = self weight

Imposed load (q_k) = 3.5 kNm^{-2}

Ultimate load = $1.4g_k + 1.6q_k$

Design load on beam = slab load + self weight of beam.

(20 marks/*markah*)

...4/-

State clearly any assumption you make. Use the following values in your calculations:-

Characteristic concrete cube strength,	f_{cu}	=	30 N/mm^2
Characteristics strength of reinforcement	f_y	=	460 N/mm^2
Characteristics strength of mild steel reinforcement	f_{yv}	=	250 N/mm^2

Nyatakan dengan jelas andaian yang anda gunakan. Gunakan nilai-nilai berikut untuk pengiraan bagi reka bentuk:-

Kekuatan ciri kiub konkrit,	f_{cu}	=	*30 N/mm^2*
Kekuatan ciri tetulang,	f_y	=	*460 N/mm^2*
Kekuatan ciri tetulang lembut	f_{yv}	=	*250 N/mm^2*

4. **Rajah 1** menunjukkan rasuk keratan Tee. Dapatkan:-

(a) Momen rintangan maksimum (M_u)

Ultimate moment of resistance (M_u)

(b) Keluasan keperluan keluli (A_s)

Area of reinforcement required (A_s)

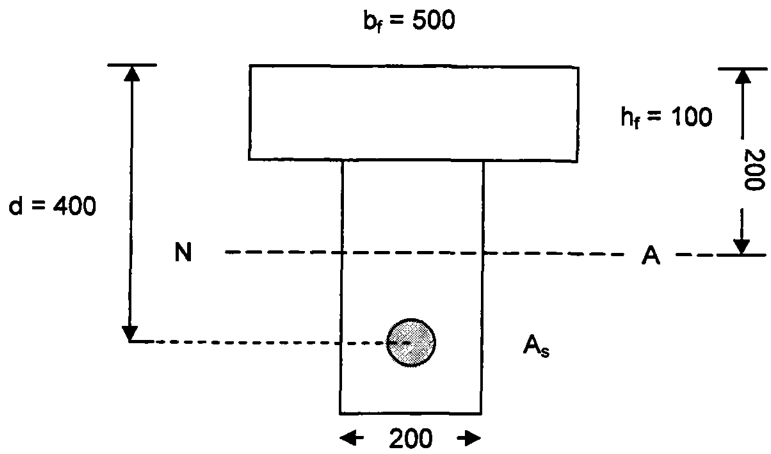


Figure 1 ***(Rajah 1)***

(20 marks/*markah*)

....5/-

5. By calculation, design a beam (bending reinforcement) shown in **Figure 2**.

Buat kiraan dan dapatkan reka bentuk sebatang rasuk (tetulang lenturan) yang ditunjukkan dalam ***Rajah 2****.*

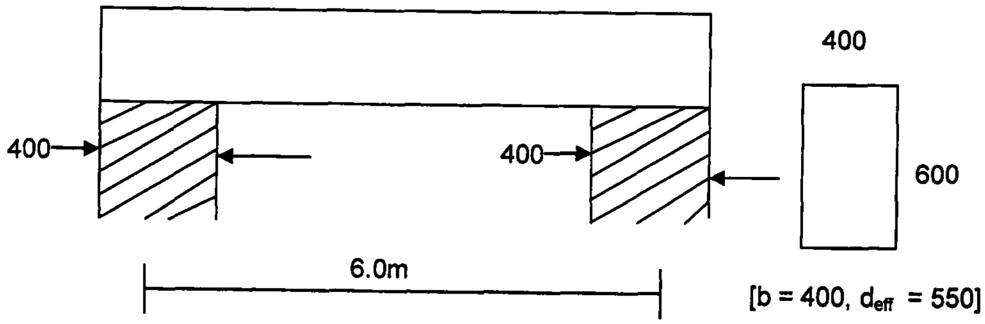


FIGURE 2 ***(RAJAH 2)***

Given:

Dead load g_k = 40 kN/m, including self-weight

Imposed load q_k = 13 kN/m

Diberi:

Beban mati g_k = 40 kN/m termasuk berat rasuk

Beban tindihan q_k = 13 kN/m

(20 marks/*markah*)

...6/-

6. A 1000 kN vertical load is applied at position A of a group of vertical piles shown in **Figure 3**. Determine the distribution of load between the individual piles.

Satu beban tegak 1000 kN dikenakan pada titik A dalam kumpulan cerucuk-cerucuk tegak seperti dalam ***Rajah 3****. Dapatkan agihan (taburan) bebanan bagi tiap-tiap cerucuk.*

(20 marks/*markah*)

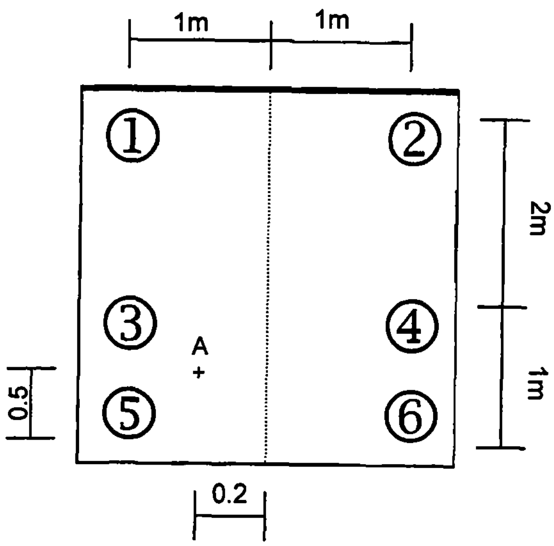
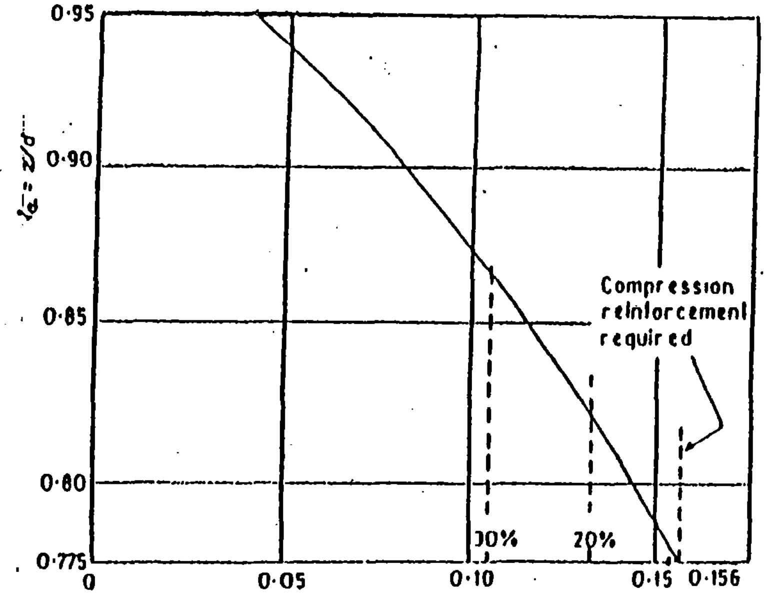


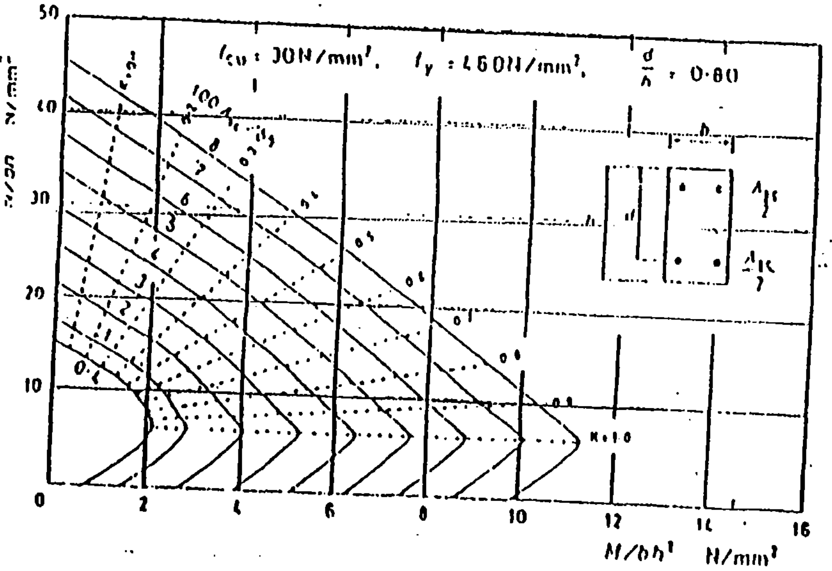
FIGURE 3 ***(RAJAH 3)***

$K = M/bd^2 f_{cu}$	0.05	0.06	0.07	0.08	0.09	0.10	0.11	0.12	0.13	0.14	0.15	0.156
$l_a = z/d$	0.941	0.926	0.915	0.901	0.887	0.873	0.857	0.842	0.825	0.807	0.789	0.775



The % values on the K axis mark the limits for singly reinforced sections with moment redistribution applied

Lever-arm curve

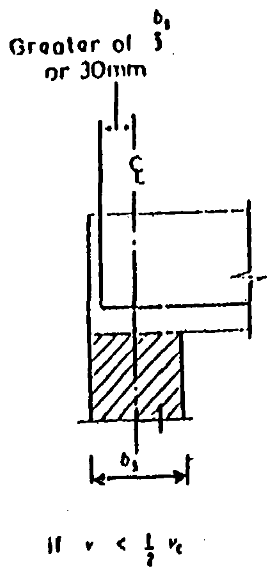


Column design chart

Value of ultimate shear stress v_c (N/mm^2) for a concrete strength of $f_{cu} = 30\ N/mm^2$

$\frac{100A_s}{bd}$	Effective depth (mm)						
	150	175	200	225	250	300	≥400
≤0.15	0.46	0.44	0.43	0.41	0.40	0.38	0.36
0.25	0.54	0.52	0.50	0.49	0.48	0.46	0.42
0.50	0.68	0.66	0.64	0.62	0.59	0.57	0.53
0.75	0.76	0.75	0.72	0.70	0.69	0.64	0.61
1.00	0.86	0.83	0.80	0.78	0.75	0.72	0.67
1.50	0.98	0.95	0.91	0.88	0.86	0.83	0.76
2.00	1.08	1.04	1.01	0.97	0.95	0.91	0.85
≥3.00	1.23	1.19	1.15	1.11	1.08	1.04	0.97

For characteristic strengths other than 30 N/mm^2 the values in the table may be multiplied by $(f_{cu}/25)^{1/3}/1.06$. The value of f_{cu} should not be greater than 40 N/mm^2.



Anchorage at simple support for a slab

Anchorage and Lap Requirements

Anchorage lengths (anchorage length $L = K_A$ x bar size)

	K_A			
	$f_{cu} = 25$	30	35	40 or more
Plain (250)				
Tension	39	36	33	31
Compression	32	29	27	25
Deformed Type 1 (460)				
Tension	51	46	43	40
Compression	41	37	34	32
Deformed Type 2 (460)				
Tension	41	37	34	32
Compression	32	29	27	26

Basic lap lengths in tension and compression (lap length = K_L x bar size)

	K_L			
	$f_{cu} = 25$	30	35	40 or more
Plain (250)	39	36	33	31
Deformed Type 1 (460)	51	46	43	40
Deformed Type 2 (460)	41	37	34	32

Minimum lap lengths : 15 x bar size or 300 mm.

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Bar Areas and Perimeters

Sectional areas of groups of bars (mm²)

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

Perimeters and weights of bars

Bar size (mm)	6	8	10	12	16	20	25	32	40
Perimeter (mm)	18.85	25.1	31.4	37.7	50.2	62.8	78.5	100.5	125.6
Weight (kg/m)	0.222	0.395	0.616	0.888	1.579	2.466	3.854	6.313	9.864

Bar weights based on a density of 7850 kg/m³.

Tension reinforcement modification factors

Reinforcement service stress	(N/mm²)	M/bd^2 0.50	0.75	1.0	1.5	2.0	3.0	4.0	5.0	6.0
	100	2.0	2.0	2.0	1.86	1.63	1.36	1.19	1.08	1.01
(f_y = 250)	156	2.0	2.0	1.96	1.66	1.47	1.24	1.10	1.00	0.94
	200	2.0	1.95	1.76	1.51	1.35	1.14	1.02	0.94	0.88
(f_y = 460)	288	1.68	1.50	1.38	1.21	1.09	0.95	0.87	0.82	0.78

Sectional areas per metre width for various bar spacings (mm²)

Bar size (mm)	Spacing of bars 50	75	100	125	150	175	200	250	300
6	566	377	283	226	189	162	142	113	94.3
8	1010	671	503	402	335	287	252	201	168
10	1570	1050	785	628	523	449	393	314	262
12	2260	1510	1130	905	754	646	566	452	377
16	4020	2680	2010	1610	1340	1150	1010	804	670
20	6280	4190	3140	2510	2090	1800	1570	1260	1050
25	9820	6550	4910	3930	3270	2810	2450	1960	1640
32	16100	10700	8040	6430	5360	4600	4020	3220	2680
40	25100	16800	12600	10100	8380	7180	6280	5030	4190

Shear Reinforcement

A_{sv}/s_v for varying stirrup diameter and spacing

Stirrup diameter (mm)	Stirrup spacing (mm) 85	90	100	125	150	175	200	225	250	275	300
8	1.183	1.118	1.006	0.805	0.671	0.575	0.503	0.447	0.402	0.366	0.335
10	1.847	1.744	1.57	1.256	1.047	0.897	0.785	0.698	0.628	0.571	0.523
12	2.659	2.511	2.26	1.808	1.507	1.291	1.13	1.004	0.904	0.822	0.753
16	4.729	4.467	4.02	3.216	2.68	2.297	2.01	1.787	1.608	1.462	1.34

Ultimate bending moment and shear force coefficients in one-way spanning slabs

	Outer support	Middle of end span	First interior support	Middle of interior span	Interior supports
Moment	0	0.086 FL	−0.086 FL	0.063 FL	−0.063 FL
Shear	0.4 F		0.6 F	-	0.5 F

Note: F is the total design ultimate load on the span, and L is the effective span

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