UNIVERSITI SAINS MALAYSIA

Peperiksaan Semester Pertama
Sidang Akademik 2004/2005

Oktober 2004

# REG 365 – Reka Bentuk Konkrit

Masa: 3 jam

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Sila pastikan bahawa kertas peperiksaan ini mengandungi **TUJUH** muka surat yang tercetak sebelum anda memulakan peperiksaan ini.

Jawab **SEMUA** soalan.

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

| | | |
|---|---|---|
| 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$^2$ |

1. Bincang dan berikan penjelasan berikut yang berkaitan dengan rekabentuk konkrit bertetulang:-

   (a) Sifat-sifat fizikal dan mekanikal konkrit bertetulangan.

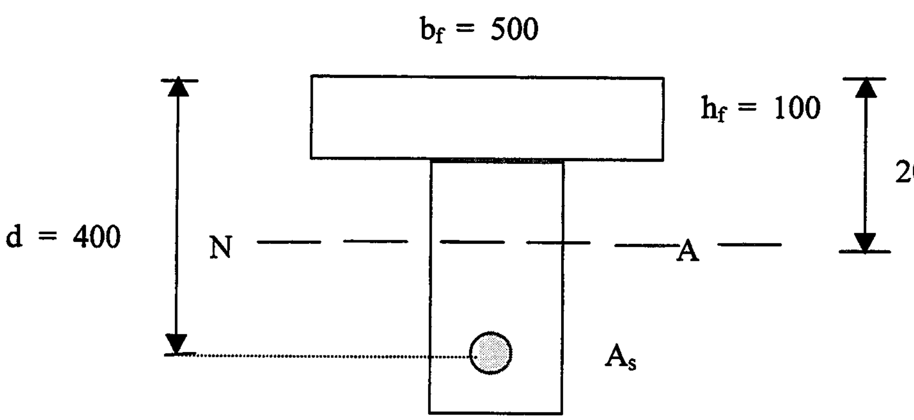
   (b) Rekabentuk berkeadaan Had.

(20 markah)

2. **Rajah 1** menunjukkan keratan Tee. Dapatkan:-

   (a) Momen rintangan maksimum ($M_u$)

   (b) Keluasan keperluan keluli ($A_s$)




**RAJAH 1**

( 20 markah )

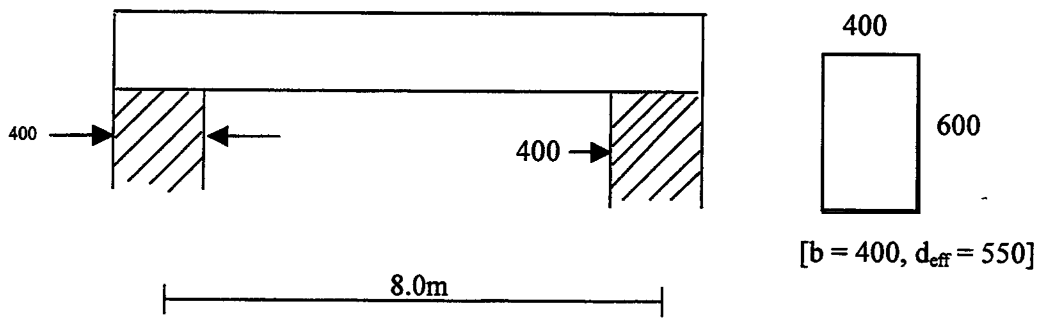
3. (a) Terangkan dengan lakaran apa maksud “Pemotongan Bar”.

(b) Tunjukkan dengan lakaran aturan ringkas untuk pemotongan hujung bar dalam:-

(i) rasuk disangga mudah; dan

(ii) rasuk selanjar

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




**RAJAH 2**

Diberi:

beban mati $g_k$ = 40 kN/m termasuk berat rasuk

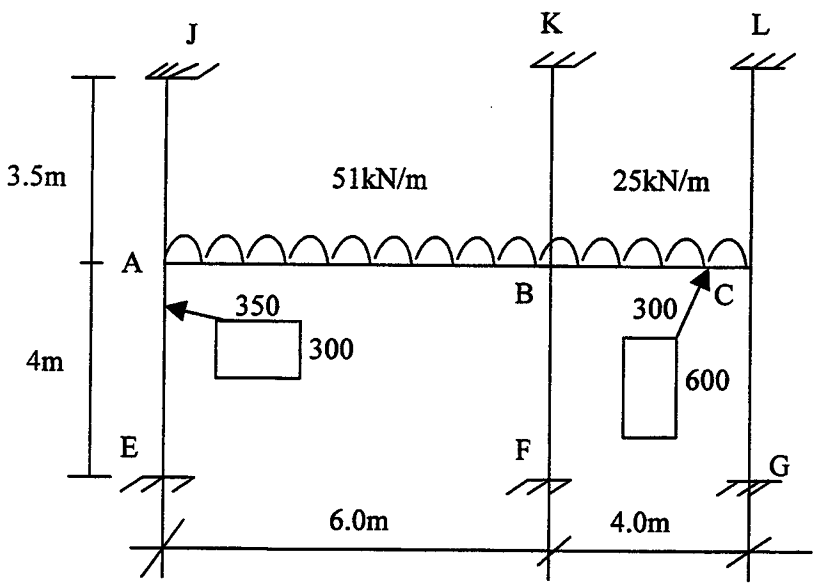
beban tindihan $q_k$ = 15 kN/m

(20 markah)

4. **Rajah 3** menunjukkan beban yang kena pada struktur rasuk AC dan tiang-tiang JE, KF, LG. Dengan menggunakan Kaedah Agihan Momen (*Moment Distribution Method*) cari dan lakarkan:-

   (a) Gambarajah Momen Lenturan bagi rasuk AC.

   (b) Gambarajah Momen Lenturan bagi tiang-tiang JE, KF dan LG.




**RAJAH 3**

(20 markah)

5. Buat kiraan dan dapatkan reka bentuk asas strip (*strip footing*) yang menanggung beberapa tiang 400 mm x 400 mm di mana jarak 4 m antara tiang. Tiap-tiap satu tiang menerima beban mati 1000 kN dan beban kena 400 kN. Diberi tekanan alas selamat atas tanah 200 kN/m$^2$. Kekuatan konkrit $f_{cu}$ = 35 N/mm$^2$ dan keluli $f_y$ = 460 N/mm$^2$.

(20 markah)

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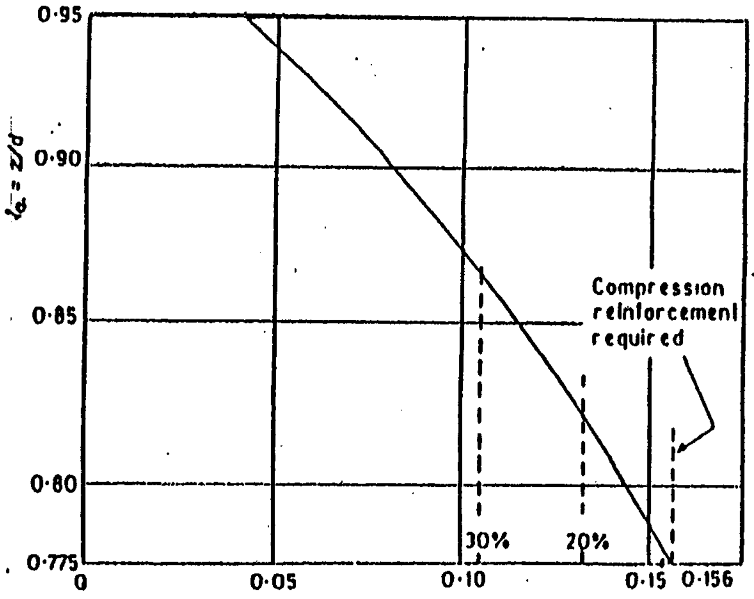
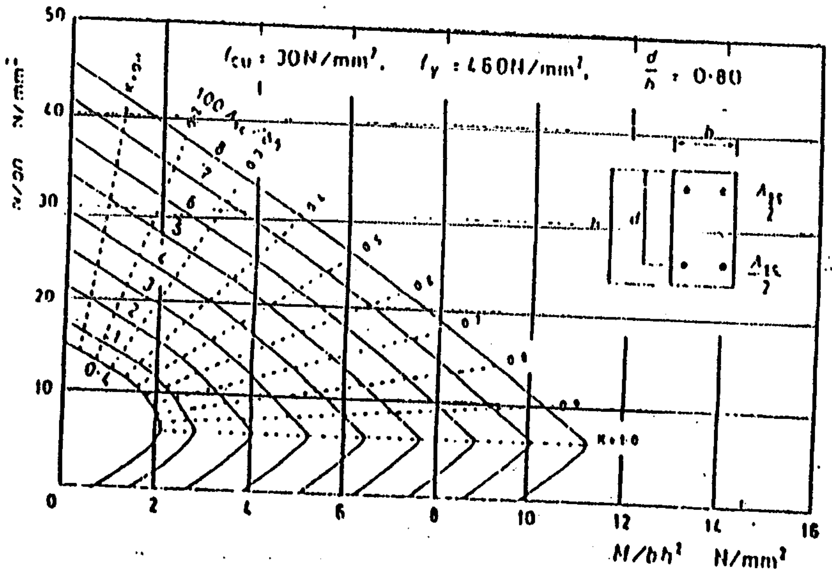
| K = $M/bd^2 f_{cu}$ | 0.05 | 0.06 | 0.07 | 0.08 | 0.09 | 0.10 | 0.11 | 0.12 | 0.13 | 0.14 | 0.15 | 0.156 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $l_a = z/d$ | 0.941 | 0.928 | 0.915 | 0.901 | 0.887 | 0.873 | 0.857 | 0.842 | 0.825 | 0.807 | 0.789 | 0.775 |




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/mm²) for a concrete strength of $f_{cu}$ = 30 N/mm²

| $\frac{100 A_s}{bd}$ | 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/mm² 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/mm².

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**Anchorage and Lap Requirements**

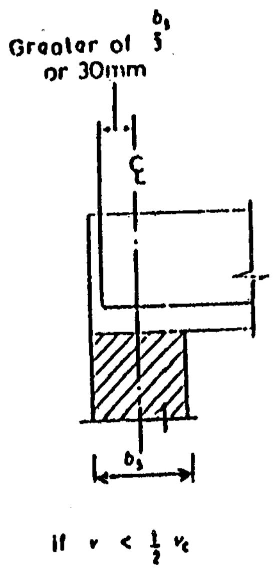
Anchorage lengths (anchorage length $L = K_A \times$ bar size)

| | $K_A$ | | | |
|---|---|---|---|---|
| | $f_{cu}$ = 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 = $K_L \times$ 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 × bar size or 300 mm.




*Anchorage at simple support for a slab*

## 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