**UNIVERSITI SAINS MALAYSIA**

**Peperiksaan Semester Pertama**
**Sidang Akademik 2001/2002**

**SEPTEMBER 2001**

**REG 365 – STRUKTUR KONKRIT**

**Masa: 3 jam**

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

Jawab **SEMUA** soalan.

Nyatakan dengan jelas apa-apa andaian anda. Gunakan nilai-nilai berikut untuk pengkiraan bagi rekabentuk.

| | | | |
|---|---|---|---|
| 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. (a) Dapatkan luas tetulang keluli (As) bagi keratan yang diberi dalam **Rajah 1**. Diberi momen rintangan maksimum (Mu) ialah 185 kNm.

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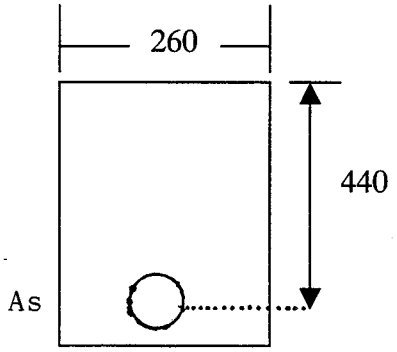
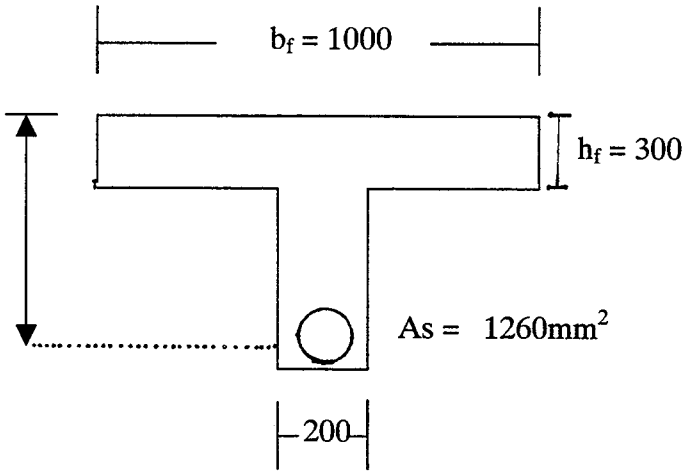
(b) Dapatkan momen rintangan maksimum (Mu) untuk keratan Tee **(Rajah 2)**.




**Rajah 1**



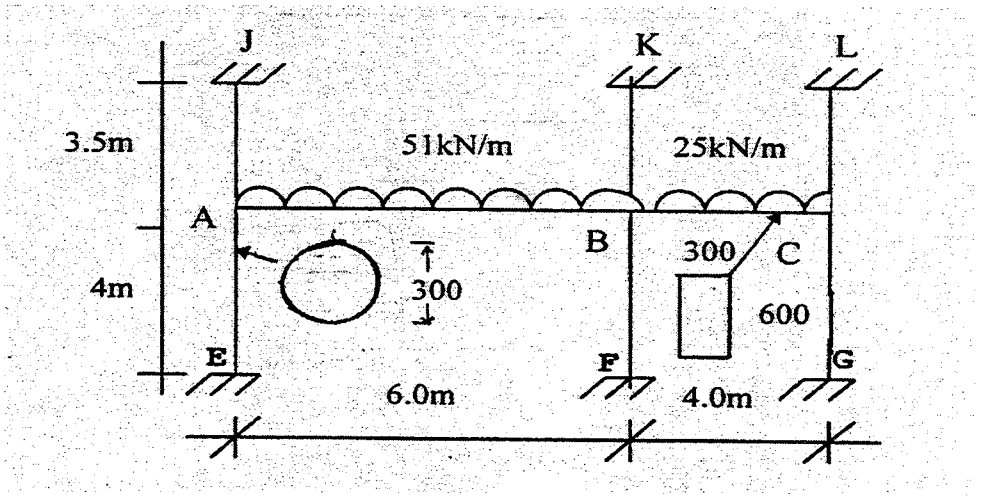

**Rajah 2**

(20 markah)

3. **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.

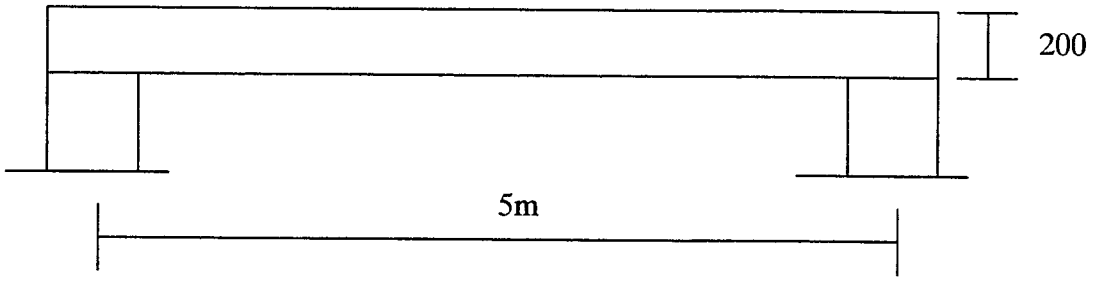
(b) Gambarajah Momen Lenturan bagi tiang-tiang JE, KF dan LG.




**RAJAH 3**

(20 markah)

4. **Rajah 4** menunjukkan satu papak konkrit bertetulangan di mana dikenakan beban mati 5 kN/m$^2$ dan beban hidup 3 kN/m$^2$. Nisbah jarak – dalaman efektif = 20. Dapatkan saiz keluli yang sesuai untuk rekabentuk papak ini.




**Rajah 4**

(20 markah)

5. Satu tiang bersegiempat tepat 400mm dikenakan beban memaksi ciri sebanyak 1200 kN bagi beban mati dan 300 kN beban tindihan. Cari asas yang diperlukan (saiz dan tetulang) untuk menentang bebanan ini.

Diberi:-

Tekanan alas selamat di atas tanah = 200 kN/m$^2$
Berat asas = 150 kN

(20 markah)

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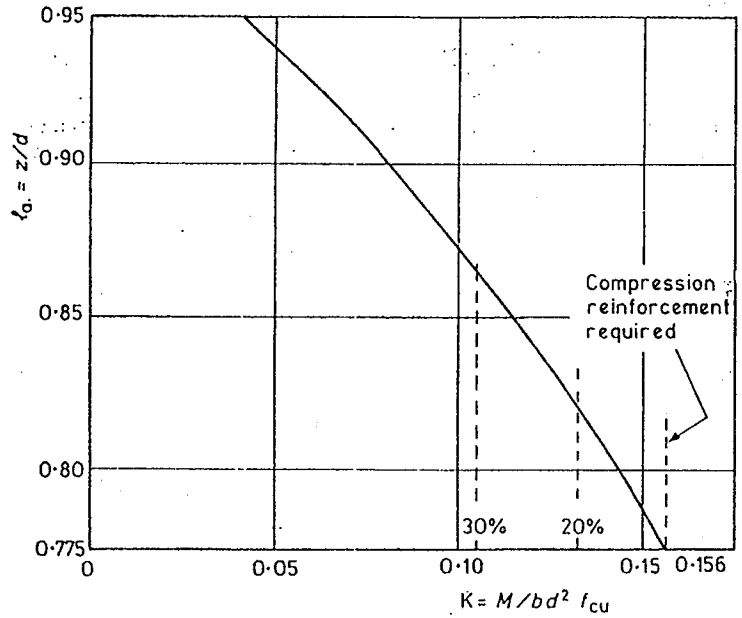
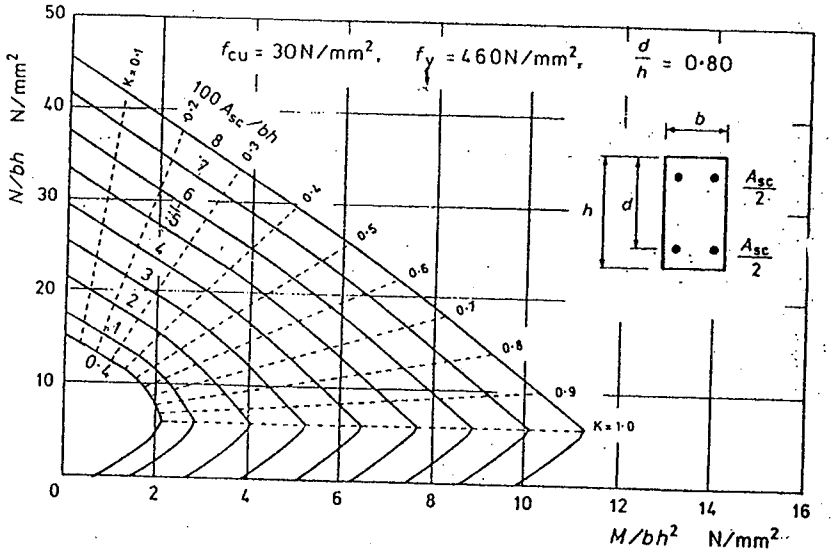
| $K = M/bd^2 f_{cu}$ | 0·05 | 0·06 | 0·07 | 0·08 | 0·09 | 0·10 | 0·11 | 0·12 | 0·13 | 0·14 | 0·15 | 0·156 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $l_a = z/d$ | 0·941 | 0·928 | 0·915 | 0·901 | 0·887 | 0·873 | 0·857 | 0·842 | 0·825 | 0·807 | 0·789 | 0·775 |




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

*Lever-arm curve*

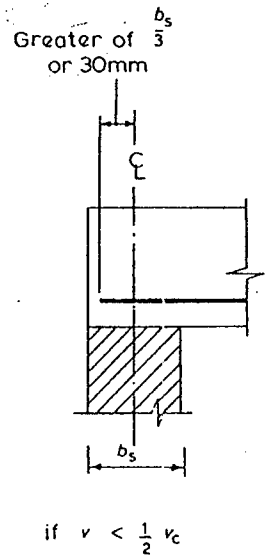



*Column design chart*

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.




*Anchorage at simple support for a slab*

**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 X bar size or 300 mm.

## Bar Areas and Perimeters

Sectional areas of groups of bars ($mm^2$)

| 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 $kg/m^3$.

Tension reinforcement modification factors

| Reinforcement service stress | | $M/bd^2$ | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | ($N/mm^2$) | 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 ($mm^2$)

| 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.