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UNIVERSITI SAINS MALAYSIA

First Semester Examination  
Academic Session 2008/2009

November 2008

**EAS 353/3 – Design Of Reinforced Concrete Structures 1**  
***[Rekabentuk Struktur Konkrit Bertetulang 1]***

Duration: 3 hours  
*[Masa : 3 jam]*

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Please check that this examination paper consists of **TEN (10)** pages of printed material including appendix before you begin the examination.

*[Sila pastikan bahawa kertas peperiksaan ini mengandungi **SEPULUH (10)** muka surat bercetak termasuk lampiran sebelum anda memulakan peperiksaan ini.]*

**Instructions:** Answer **FIVE (5)** questions. All questions carry the same marks.

**Arahan:** Jawab **LIMA (5)** soalan sahaja. Semua soalan membawa jumlah markah yang sama.

You may answer the question either in Bahasa Malaysia or English.

*[Anda dibenarkan menjawab soalan sama ada dalam Bahasa Malaysia atau Bahasa Inggeris.]*

All questions **MUST BE** answered on a new sheet.

*[Semua jawapan **MESTILAH** dijawab pada muka surat baru.]*

Write the answered question numbers on the cover sheet of the answer script.

*[Tuliskan nombor soalan yang dijawab di luar kulit buku jawapan anda.]*

1. (a) Staircase is defined as a structure spanning in the direction of the stair flight between beams, walls or landings located at the top and bottom of the flight. It may include a section of landing spanning in the same direction and continuous with the stair flight. State and sketch **FIVE (5)** common types of staircase normally used for building.

[5 marks/markah]

*Papan tangga didefinisikan sebagai sebuah struktur yang merentangi arah larian tangga antara rasuk, dinding atau daratan terletak pada bahagian atas atau bawah larian. Ia mungkin termasuk keratan daratan yang merentangi arah yang sama dan selanjar dengan larian tangga. Nyatakan dan lakarkan **LIMA (5)** jenis tangga yang biasa digunakan untuk bangunan.*

- (b) Figure 1 shows part of a first floor plan for a double storey bungalow. In order to design the reinforced concrete floor, the following data are given :-

|   |                            |
|---|----------------------------|
| Characteristic strength of concrete, $f_{cu}$         | 25N/mm <sup>2</sup>        |
| Characteristic strength reinforcement, $f_y$          | 250N/mm <sup>2</sup>       |
| Concrete cover  | 20mm                       |
| Diameter of reinforcement                             | 12mm                       |
| Slab thickness  | 150mm                      |
| Finishing and services                                | 1.0kN/m <sup>2</sup>       |
| Imposed load  | 5.0kN/m <sup>2</sup>       |
| <i>Ciri-ciri kekuatan konkrit <math>f_{cu}</math></i> | <i>25N/mm<sup>2</sup></i>  |
| <i>Ciri-ciri kekuatan tetulang, <math>f_y</math></i>  | <i>250N/mm<sup>2</sup></i> |
| <i>Tutupan konkrit</i>                                | <i>20mm</i>                |
| <i>Garis pusat tetulang</i>                           | <i>12mm</i>                |
| <i>Tebal papak</i>                                    | <i>150mm</i>               |
| <i>Turapan dan perkhidmatan</i>                       | <i>1.0kN/m<sup>2</sup></i> |
| <i>Beban kenaan</i>                                   | <i>5.0kN/m<sup>2</sup></i> |

*Rajah 1 menunjukkan sebahagian pelan lantai sebuah rumah dua tingkat. Untuk merekabentuk lantai konkrit bertetulang, data-data berikut diberi:-*

- (i) Calculate the moment and shear force values for slab FG/1-2

[2 marks/markah]

*Kirakan nilai-nilai lenturan dan daya ricih untuk papak FG /1-2*

- (ii) Determine the amount of reinforcement required for slab FG/1-2. Ignore the torsion reinforcement.

[5 marks/markah]

*Peroleh jumlah tetulang yang diperlukan untuk papak FG /1-2. Abaikan tetulang kilasan.*

- (iii) Check shear, deflection and cracking for slab FG/1-2.

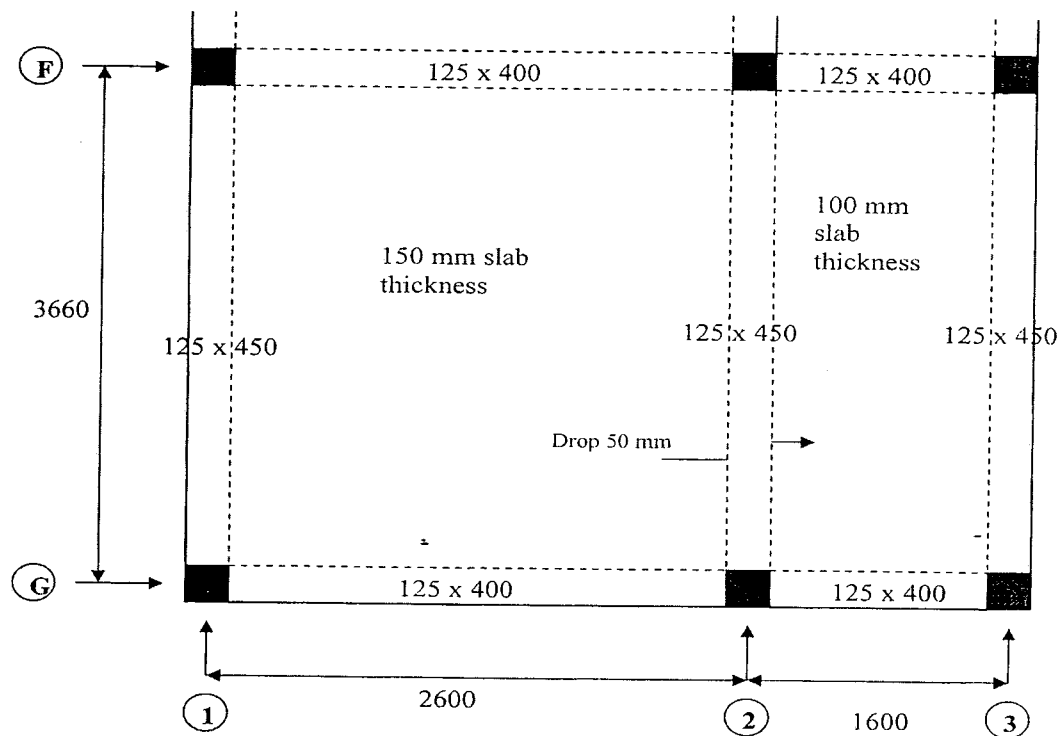
[3 marks/markah]

*Semakan untuk ricih pesongan dan ratakan untuk papak FG /1-2*

- (iv) Show out the arrangement of reinforcement in plan and cross sections for both spans.

[5 marks/markah]

*Paparkan aturan tetulang dalam pelan dan keratan untuk kedua-dua rentang.*



Figure/Rajah 1 : First Floor Slab Plan

2. (a) State the criteria for choosing the appropriate dimensions of a combined pad footing.  
(2 marks/markah)

*Senaraikan kriteria pemilihan dimensi yang sesuai untuk asas tergabung.*

- (b) A proposed dimension for a combined footing is shown in Figure 2(a) and 2(b). If the column loads are under serviceability limit and considering the allowable ground bearing pressure as  $200\text{kN/mm}^2$  :-
- verify the proposed dimensions of the combined footing (concrete density =  $24\text{kN/m}^3$ )
  - calculate Bending Moment and Shear Force and provide relevant sketches
  - provide the shear check
  - design the required reinforcement
  - provide sectional reinforcement detailing

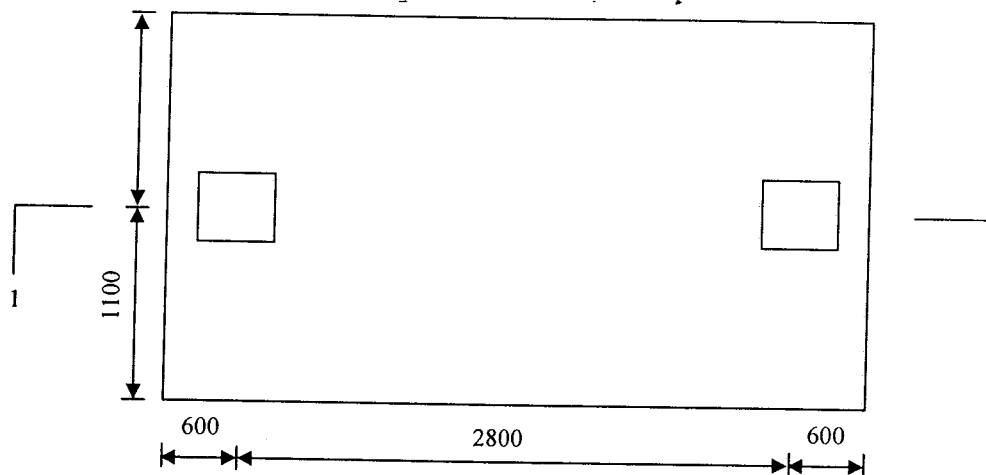
The characteristic strength of concrete and reinforcement shall be  $35\text{N/mm}^2$  and  $460\text{N/mm}^2$  respectively. Mean effective depth ( $d$ ) of the combined footing is taken as  $520\text{mm}$ .

[18 marks/markah]

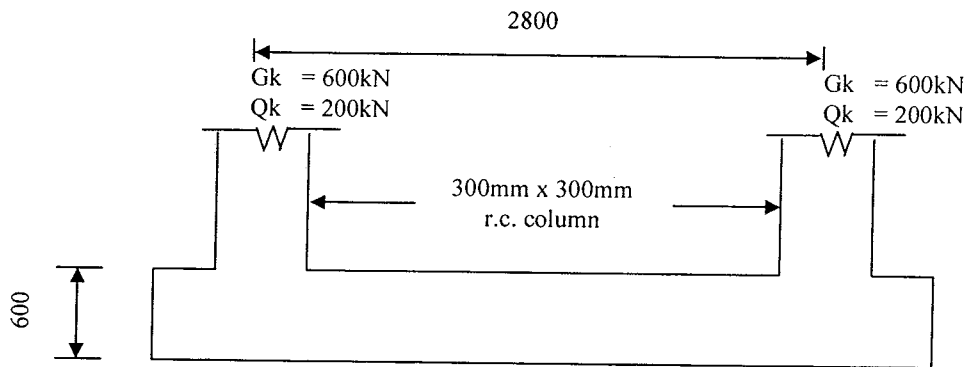
Dimensi yang dicadangkan untuk satu asas tergabung adalah seperti di Rajah 2(a) dan 2(b). Sekiranya bebanan tiang adalah pada had kebolehhidmatan dan mempertimbangkan keupayaan galas tanah dibenarkan  $200\text{kN/m}^2$  :-

- (i) tentusahkan dimensi cadangan asas tergabung (ketumpatan konkrit =  $24\text{kN/m}^3$ )
- (ii) kira Momen Lentur dan Daya Ricih serta sediakan lakaran yang sesuai
- (iii) sediakan semakan terhadap ricihan
- (iv) rekabentuk tetulang yang diperlukan
- (v) sediakan keratan perician tetulang

Kekuatan ciri konkrit dan tetulang adalah masing-masing  $35\text{N/mm}^2$  dan  $460\text{N/mm}^2$ . Purata kedalaman berkesan ( $d$ ) asas tergabung diambil sebagai  $520\text{mm}$ .



Figure/Rajah 2(a) : Plan View



Figure/Rajah 2(b) : Section 1-1

3. (a) State **TWO (2)** components that can resist shear force in the case of a reinforced concrete beam without shear reinforcement.

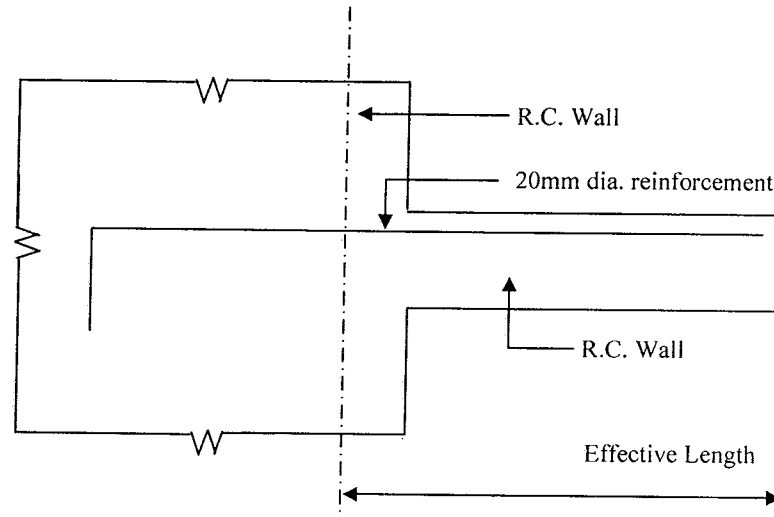
[2 marks/markah]

*Senaraikan DUA (2) komponen yang boleh merintang ricih rasuk dalam kes rasuk konkrit bertetulang tanpa tetulang ricih.*

- (b) Determine the length of tension anchorage required for 20mm diameter reinforcement with  $90^\circ$  bend as shown in Figure 3. The characteristic strength of concrete and reinforcement shall be  $30\text{N/mm}^2$  and  $460\text{N/mm}^2$  respectively. Assume the tensile stress the reinforcement is  $0.5f_y$  and side cover to reinforcement is 30mm. Provide a sketch showing the required anchorage length beyond the effective span of the beam.

[8 marks/markah]

*Tentukan panjang tambatan yang diperlukan untuk tetulang tegangan bergaris pusat 20mm dengan  $90^\circ$  bengkokan seperti di Rajah 3. Kekuatan ciri konkrit dan tetulang adalah masing-masing  $30\text{N/mm}^2$  dan  $460\text{N/mm}^2$ . Anggap tetulang tersebut ditahap tegasan tegangan rekabentuk  $0.5f_y$ . Penutup sisi tetulang diambil sebagai 30mm. Sediakan lakaran yang menunjukkan panjang tambatan yang diperlukan selepas panjang rentangan berkesan rasuk.*

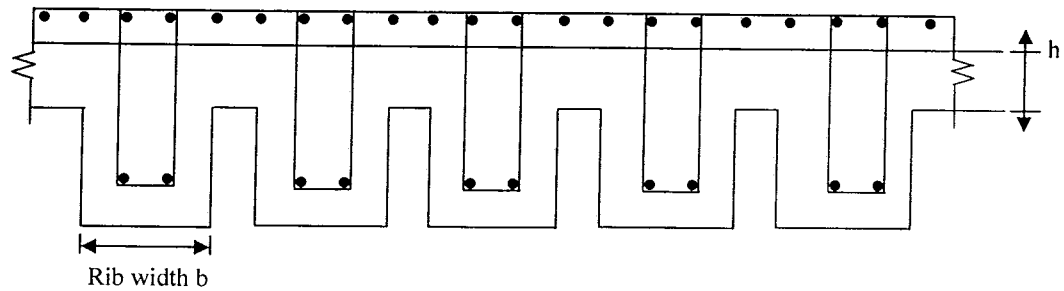


Figure/Rajah 3 : Cantilever Beam with 90<sup>0</sup> Bend Reinforcement

- (c) A braced slender column of 300 mm x 300 mm cross section is subjected to ultimate axial load of 1200kN. Two end moments of -10kNm and 50kNm causing the column to experience double curvature. The column's effective height,  $l_{ex}$  and  $l_{ey}$  are 6.5m. The characteristic strength of concrete and reinforcement shall be 30N/mm<sup>2</sup> and 460N/mm<sup>2</sup> respectively. Design and provide sectional reinforcement detailing of the column considering  $d/h$  as 0.85. Assume K value as 1.0 and no iteration is required.

[10 marks/markah]

*Satu tiang langsing terambat berkeratan rentas 300 mm x 300 mm dikenakan beban paksi 1200kN. Dua momen hujung -10kNm dan 50kNm menyebabkan tiang mengalami keadaan dwi-lenturan. Panjang berkesan tiang,  $l_{ex}$  dan  $l_{ey}$  adalah 6.5m. Kekuatan ciri konkrit dan tetulang adalah masing-masing 30N/mm<sup>2</sup> dan 460N/mm<sup>2</sup>. Rekabentuk dan sediakan perincian tetulang tiang dengan menganggap  $d/h$  sebagai 0.85. Anggap nilai K sebagai 1.0 dan tiada lelaran diperlukan.*



Figure/Rajah 3

4. (a) A continuous ribbed floor slab is exposed on the underside and protected on the topside as shown in Figure 3 above.

*Sebuah papak lantai berusuk t rdedah di bahagian bawah dan terlindung di bahagian atas, seperti di dalam rajah 3 di atas.*

The ribbed floor slab is designed using concrete grade C35, and the nominal maximum aggregate size is 20mm. The diameter of the main tension steel is 30mm and the diameter of the shear links are 10mm. The minimum required fire resistance is 2 hours.

*Papan lantai berusuk tersebut direkabentuk menggunakan konkrit gred C35, dan saiz aggregate maksima namaan adalah 20mm. Garispusat keluli tegangan utama ialah 30mm dan garispusat pengikat ricih ialah 10mm. Masa minima ketahanan kebakaran ialah 2 jam.*

Determine :-

- (i) The nominal cover required for the topside of the floor
- (ii) The nominal cover required for the underside of the rib
- (iii) The minimum floor thickness
- (iv) The width of the rib if the bars are placed horizontally

[15 marks/markah]



*Peroleh :-*

- (i) *Tutupan namaan yang diperlukan lantai bahagian atas*
- (ii) *Tutupan namaan yang diperlukan untuk bahagian bawah berusuk*
- (iii) *Ketebalan lantai minima*
- (iv) *Lebar berusuk jika bar diatur mendatar*

- (b) Spalling may occur if the cover exceeds 40mm for dense concrete or 50mm for lightweight concrete. Please suggest **FIVE (5)** measures to overcome spalling.

[5marks/markah]

*Jika tutupan melebihi 40mm untuk konkrit mampat atau 50mm untuk konkrit mungkin akan berlaku serpihan . Cadangkan **LIMA (5)** kaedah untuk mengatasi serpihan.*

5. A **TWO (2)**-span continuous beam has the following characteristics :-

*Sebuah rasuk bersaiz 300mm x 50mm dua rentang berterusan mempunyai ciri-ciri berikut :-*

$$F_{cu} = 45\text{N/mm}^2$$

$$F_y = 460\text{N/mm}^2$$

$$h_{agg} = 20\text{mm}$$

Exposure condition = severe

minimum fire resistance = 1.0hr

If the bending moment at mid-span is 500kNm and at central support is 450kNm. determine suitable main reinforcement for the beam at mid-span and central support.

[20 marks/markah]