UNIVERSITI SAINS MALAYSIA

First Semester Examination
2015/2016 Academic Session

December 2015 / January 2016

EAA455 – Reinforced Concrete Structural Design II
[Rekabentuk Struktur Konkrit Bertetulang II]

Duration : 2 hours
[*Masa : 2 jam*]

Please check that this examination paper consists of **TWELVE (12)** pages of printed material including **THREE (3)** appendices before you begin the examination.
[*Sila pastikan bahawa kertas peperiksaan ini mengandungi* ***DUA BELAS (12)*** *muka surat yang bercetak termasuk* ***TIGA (3)*** *lampiran sebelum anda memulakan peperiksaan ini.*]

Instructions : This paper contains **FIVE (5)** questions. Answer **FOUR (4)** questions.
[***Arahan*** *: Kertas ini mengandungi* ***LIMA (5)*** *soalan. Jawab* ***EMPAT (4)*** *soalan.*]

All questions **MUST BE** answered on a new page.
[*Semua soalan* ***MESTILAH*** *dijawab pada muka surat baru.*]

In the event of any discrepancies, the English version shall be used.
[*Sekiranya terdapat percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah diguna pakai.*]

1. [a] Compare the working capacity of a 200 mm diameter micropile derived from the 'reinforcement strength' with the 'short column' methods. Use the following data:

- Reinforcement = 6 T16 (f_y = 460 N/mm^2)
- Modulus of Elasticity (Steel) = 200 kN/mm^2
- Characteristic strength of grout = 30 N/mm^2
- Modulus of Elasticity (Grout) = 17 kN/mm^2
- Factor of safety = 2.0

Bandingkan keupayaan kerja satu cerucuk mikro bergarispusat 200 mm yang diterbit daripada kaedah 'kekuatan tetulang' berbanding dengan kaedah 'tiang pendek'. Guna maklumat berikut:

- *Tetulang = 6 T16 (f_y = 460 N/mm^2)*
- *Modulus Keanjalan (keluli) = 200 kN/mm^2*
- *Kekuatan ciri turap = 30 N/mm^2*
- *Modulus Keanjalan (turap) = 17 kN/mm^2*
- *Faktor keselamatan = 2.0*

[5 marks/*markah*]

[b] A pile cap with four pile group is supporting a circular column with eccentricity as shown in **Figure 1**. Examine the distribution of the pile capacity between the individual piles and the total pile group capacity if the column load and pile working load is 800 kN and 250 kN, respectively. Evaluate the overall results of the pile capacity check.

Satu tetopi cerucuk yang mengandungi sekumpulan empat cerucuk menanggung tiang bulat dengan kesipian seperti di ***Rajah 1****. Periksa agihan keupayaan cerucuk di antara setiap cerucuk dan jumlah keseluruhan keupayaan kumpulan cerucuk sekiranya beban tiang dan keupayaan kerja cerucuk masing masing adalah 800 kN dan 250 kN. Nilaikan keputusan keseluruhan semakan keupayaan cerucuk tersebut.*

[20 marks/*markah*]

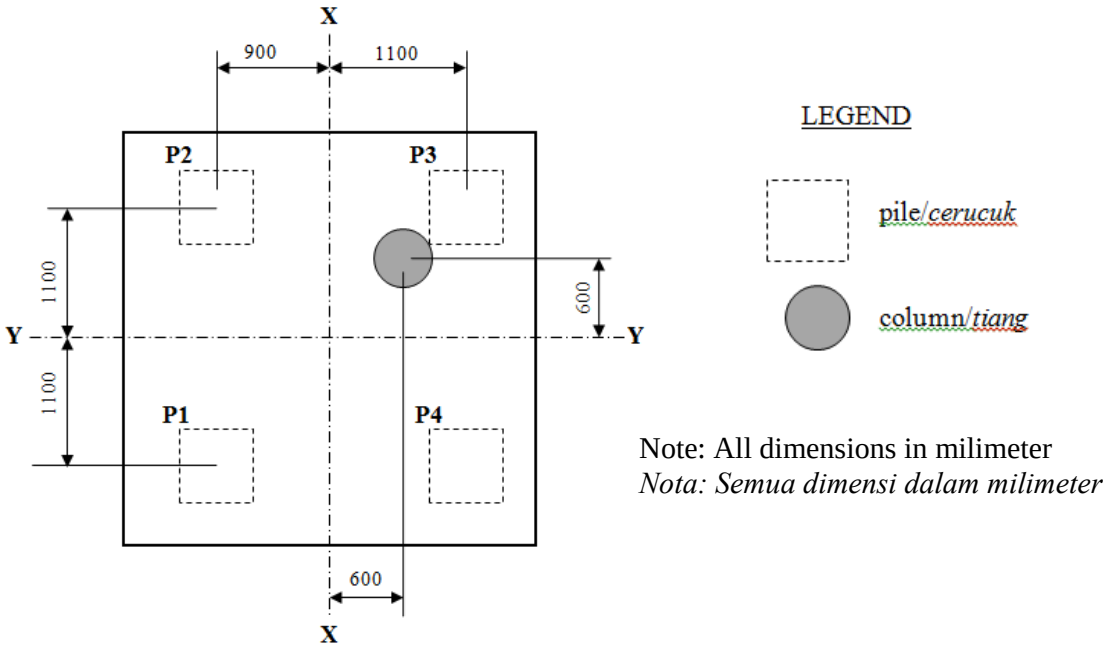


Figure 1/*Rajah 1*

2. The plan for a four pile group pile cap is shown in **Figure 2**. The 1.6 m × 1.6 m × 0.9 m thick pile cap is subjected to an ultimate design load (inclusive self-weight of the pile cap) of 4200 kN. Design the pile cap using Bending Theory method and provide detailing in accordance to BS 8110: 1997. Use the following information:

- Column size = 400 mm × 400 mm
- Pile cap reinforcement = T 25 (f_y = 460 N/mm^2)
- Characteristic strength of concrete = 30 N/mm^2
- Pile size = 300 mm × 300 mm
- Pile working capacity = 800 kN

- Embedded length = 75 mm
- Edge distance = 150 mm
- Concrete cover = 50 mm
- Loop reinforcement = 4 T12

Please use the base drawing provided in **Appendix 3**.

*Pelan untuk tetopi cerucuk dengan sekumpulan empat cerucuk ditunjukkan di **Rajah 2**. Tetopi cerucuk bersaiz 1.6 m × 1.6 m × 0.9 m tebal menanggung beban rekabentuk muktamad (termasuk berat diri tetopi cerucuk) 4200 kN. Rekabentuk tetopi cerucuk tersebut menggunakan kaedah Teori Lenturan dan sediakan perincian dengan mematuhi BS 8110: 1997.*

- *Saiz tiang* = *400 mm × 400 mm*
- *Tetulang tetopi cerucuk* = *T25 (f_y = 460 N/mm^2)*
- *Kekuatan ciri konkrit* = *30 N/mm^2*
- *Saiz cerucuk* = *300 mm × 300 mm*
- *Keupayaan kerja cerucuk* = *800 kN*
- *Panjang tertanam* = *75 mm*
- *Jarak hujung* = *150 mm*
- *Lapis Konkrit* = *50 mm*
- *Tetulang gelung* = *4 T12*

*Sila gunakan lukisan asas yang disediakan di **Lampiran 3**.*

[25marks/*markah*]

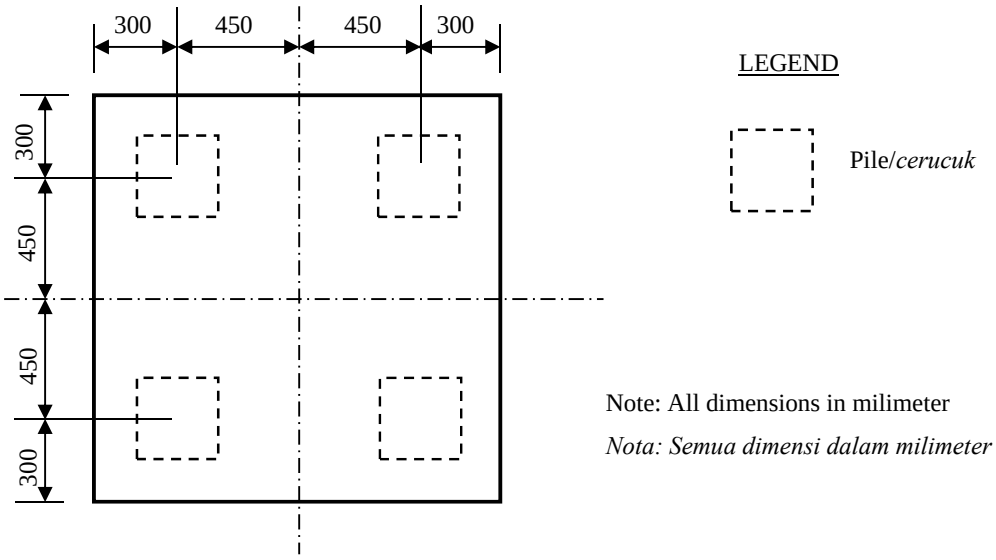


Figure 2/*Rajah 2*

3. The part plan of a flat slab layout is shown in **Figure 3**. The 200 mm thick slab panels are to have drops of 2.0 m × 2.0 m × 250 mm (d_h = 50 mm). Design the bending reinforcement and check the punching shear at column face. Provide sectional details at A-A. Use the following information:

- Ultimate Design Load = 14.0 kN/m^2
- Column size = 400 mm × 400 mm
- Characteristic strength of concrete = 30 N/mm^2
- Flat slab reinforcement = T 12 (f_y = 460 N/mm^2)
- Concrete cover = 25 mm

*Sebahagian pelan lantai rata ditunjukkan di **Rajah 3**. Lantai setebal 200 mm mempunyai panel jatuhan bersaiz 2.0 m × 2.0 m × 250 mm (d_h = 50 mm). Rekabentuk tetulang lenturan dan semak ricih tebukan pada permukaan tiang. Sediakan perincian keratan pada A-A. Gunakan maklumat berikut:*

- *Beban rekabentuk muktamad* = *14.0 kN/m²*
- *Saiz tiang* = *400 mm × 400 mm*
- *Kekuatan ciri konkrit* = *30 N/mm²*
- *Tetulang lantai rata* = *T 12 (f_y = 460 N/mm²)*
- *Penutup konkrit* = *25 mm*

[25 marks/*markah*]

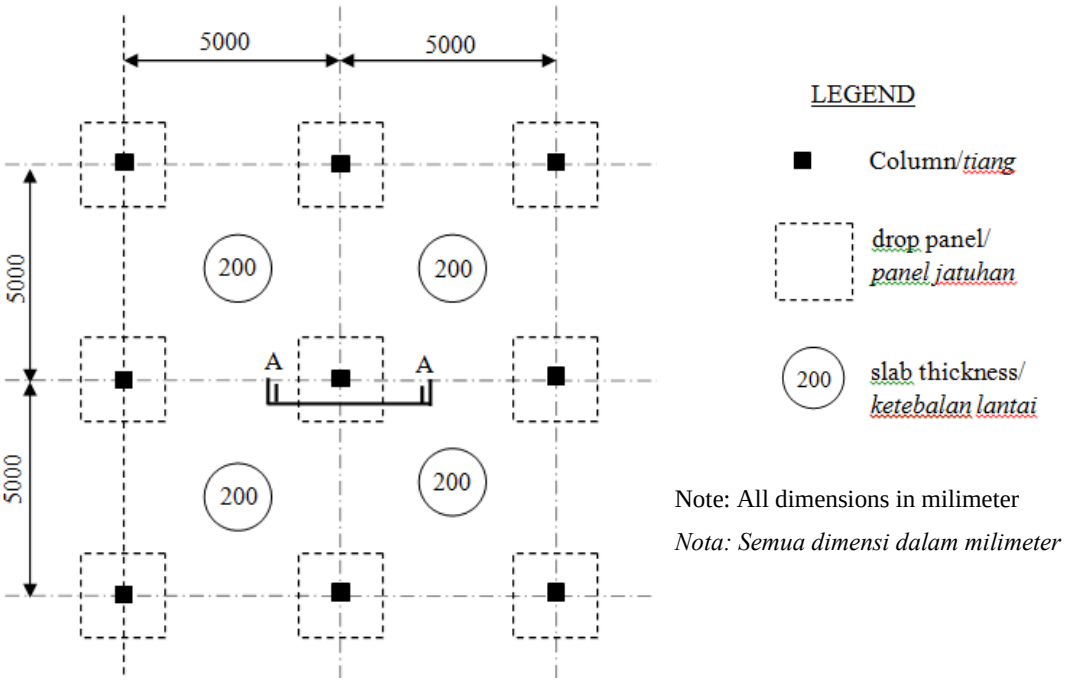


Figure 3/*Rajah 3*

4. A retaining wall shown in **Figure 4** is proposed to retain earth. The angle of soil friction is 30°. Maximum allowable pressure of soil is 200 kN/m^3 and the density of earth is 18 kN/m^3. The retaining wall is constructed using grade 30 concrete, the steel reinforcement characteristic strength is f_{yv} = 250 N/mm^2, concrete weight 24 kN/m^3 and the concrete cover is 30 mm. The coefficient of friction between the soil and wall is 0.6. The recommended steel reinforcement is 12 mm bars. Curtailment of reinforcement in stem is at height 1.50 m. Distribution steel and temperature reinforcement are required using 10 mm bars. Assume μ = 0.5.

Sebuah tembok penahan yang ditunjukkan dalam ***Rajah 4*** *dicadangkan untuk menahan tanah. Sudut geseran dalaman tanah ialah 30^o. Keupayaan galas selamat tanah ialah 200 kN/m^3 dan ketumpatan tanah adalah 18 kN/m^3. Dinding penahan dibina menggunakan konkrit gred 30, kekuatan ciri tetulang keluli ialah f_{yv} = 250 N/mm^2, berat konkrit adalah 24 kN/m^3 dan lapis konkrit ialah 30 mm. Pekali geseran antara tanah dan tembok adalah 0.6. Tetulang yang disyorkan ialah bar 12 mm. Pemotongan besi tetulang di linggi adalah pada ketinggian 1.50 m. Keluli agihan dan tetulang suhu diperlukan dengan menggunakan bar 10 mm.* Andai μ = 0.5

[i] Determine the overall stability of the retaining wall.
Tentukan kestabilan tembok penahan ini.

[8 marks/*markah*]

[ii] Using BS8100:1997, design the reinforcement for the retaining wall stem only.

Menggunakan BS8110:199, rekabentuk tetulang untuk linggi tembok penahan tersebut sahaja.

[17 marks/*markah*]

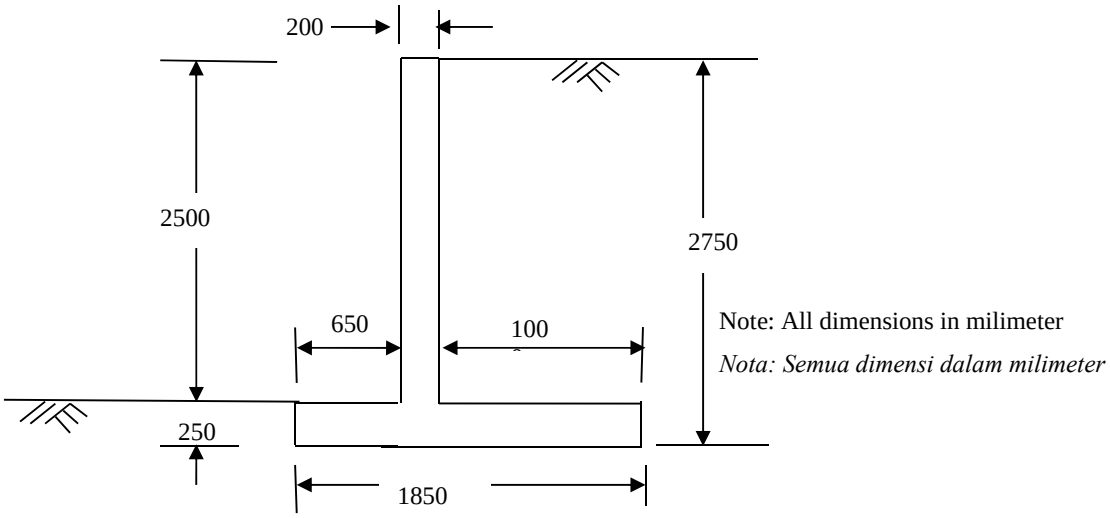


Figure 4/*Rajah 4*

5. [a] Consider a rectangular beam with uniformly distributed load, ***w*** and pre-stressed by a tendon placed eccentrically to the concrete cross section. The resultant compressive force in the concrete acts at the centroid of the tendon at a distance, ***e*** below the neutral axis of the section as shown in **Figure 5**. Determine the stress distribution equation across the pre-stressed concrete section with the aid of stress distribution diagrams for the top and bottom fibre.

Pertimbangkan satu rasuk pra-tegasan segiempat tepat yang dikenakan beban teragih seragam, ***w*** *dan mempunyai kesipian tendon pada permukaan rentas konkrit. Jumlah daya mampatan dalam konkrit bertindak pada sentroid tendon pada jarak kesipian,* ***e*** *di bawah paksi neutral keratan seperti* ***Rajah 5****. Tentukan persamaan agihan tegasan keratan konkrit pra-tegasan tersebut dengan bantuan gambarajah agihan tegasan bagi gentian atas dan bawah.*

[*10* mark*s/markah*]

[b] A pre-stressed concrete rectangular beam 500 mm × 750 mm with 7.30 m span is loaded by a uniformly distributed load of 40 kN/m including its own self-weight. The pre-stressing tendon is located 145 mm below the neutral axis and produces an effective pre-stress of 1620 kN. Calculate the top and bottom fibre stresses in the concrete at mid span. Provide the relevant stress block diagrams.

Satu rasuk konkrit pra-tegasan segiempat tepat 500 mm × 750 mm dengan rentang 7.30 m dikenakan beban teragih seragam sebanyak 40 kN/m termasuk berat diri sendiri. Tendon terletak 145 mm di bawah paksi neutral dan menghasilkan pra-tegasan berkesan 1620 kN. Kira tegasan gentian atas dan bawah di dalam konkrit di pertengahan rentang. Sediakan gambarajah blok tegasan yang berkaitan.

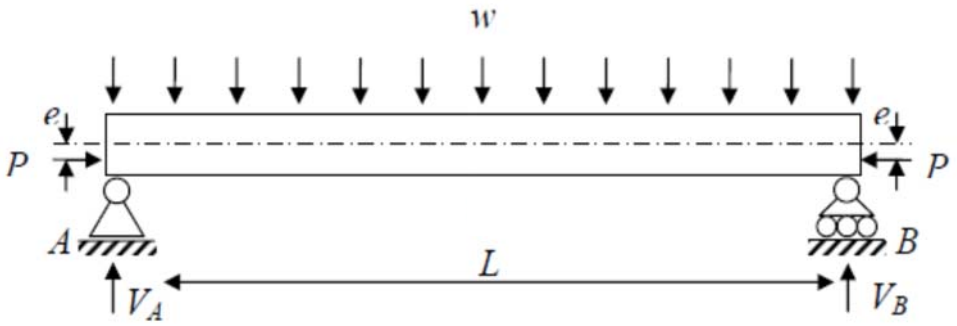


Figure 5/Rajah 5

[*15 marks/markah*]

APPENDIX 1/ ***LAMPIRAN 1***

1. Pile capacity check:

$$\boldsymbol{P_n = \frac{P}{N} \pm \frac{M_{xx}\, y_n}{I_{xx}} \pm \frac{M_{yy}\, x_n}{I_{yy}}}$$

2. Base inertia:

$$\boldsymbol{I = (N_1 \times y_1^2) + (N_2 \times y_2^2) + \ldots\ldots (N_n \times y_n^2)}$$

3. Shear enhancement:

$$\boldsymbol{= \frac{v_c \times 2 \times d}{a_v}}$$

APPENDIX 2/ *LAMPIRAN 2*

Bar Areas and Perimeters

Sectional areas of groups of bars (mm^2)

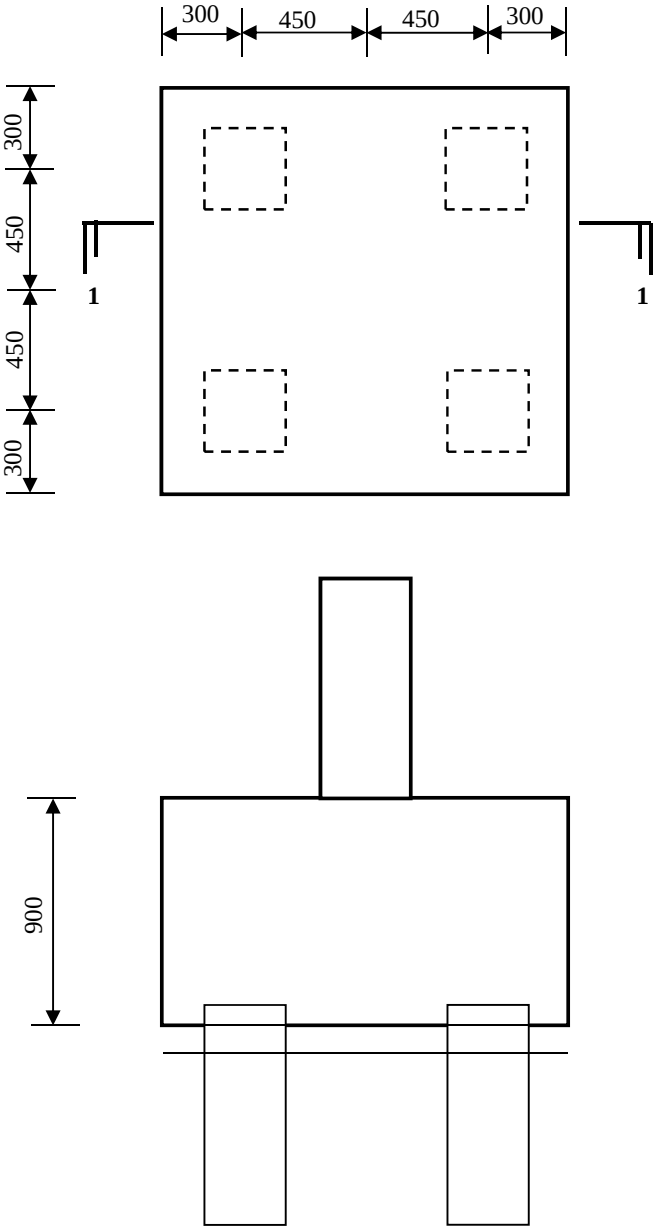
Bar size (mm)	Number of bars									
	1	2	3	4	5	6	7	8	9	10
6	28.3	56.6	84.9	113	142	170	198	226	255	283
8	50.3	101	151	201	252	302	352	402	453	503
10	78.5	157	236	314	393	471	550	628	707	785
12	113	226	339	452	566	679	792	905	1020	1130
16	201	402	603	804	1010	1210	1410	1610	1810	2010
20	314	628	943	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

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

ANGKA GILIRAN:_____

APPENDIX 3/ *LAMPIRAN 3*



Base drawings (to be attached with answer script)

Lukisan asas (untuk dikepilkan bersama buku jawapan)

-oooOOOooo-