UNIVERSITI SAINS MALAYSIA

First Semester Examination
2010/2011 Academic Session

November 2010

EAS 353/3 – Reinforced Concrete Structural Design 1

[*Rekabentuk Struktur Konkrit Bertetulang 1*]

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

Please check that this examination paper consists of **TEN (10)** pages of printed material before you begin the examination.
[*Sila pastikan bahawa kertas peperiksaan ini mengandungi **SEPULUH (10)** muka surat yang bercetak sebelum anda memulakan peperiksaan ini.*]

Instructions : This paper contains **SIX (6)** questions. Answer **FIVE (5)** questions**.**
[***Arahan** : Kertas ini mempunyai **ENAM (6)** soalan. Jawab **LIMA (5)** soalan.*

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 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 akan diguna pakai*].

1. a) There are two principles of limit state namely the ultimate limit state (ULS) and the serviceability limit state (SLS). Briefly describe both principles in reinforced concrete design.

[6 marks]

b) The ultimate design moment to be resisted by the T-section beam as shown in Figure 1.0 is 200 kNm. The characteristic strengths of reinforcement and concrete are f_y = 460 N/mm^2 and f_{cu} = 30 N/mm^2, respectively. Assuming the depth of the stress blok below the flange, calculate the area of tension reinforcement required using simplified rectangular stress block method.

[14 marks]

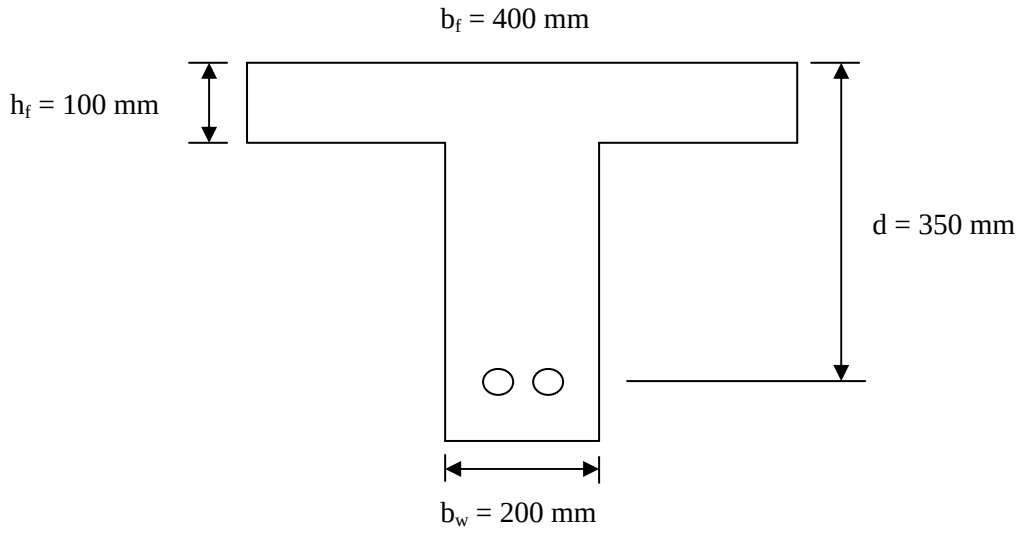


Figure 1.0 : Cross-section of T-beam.

2. a) A simply supported square concrete slab spanning in two directions as shown in Figure 2.0 is to be designed to carry an imposed load of 3.5 kN/m^2, finishes and ceiling of 1.0 kN/m^2 excluding the selfweight of slab. The characteristic strengths of the materials are f_{cu} = 30 N/mm^2 and f_y = 460 N/mm^2. Assume span-effective depth ratio of 20 with modification factor of 1.3.

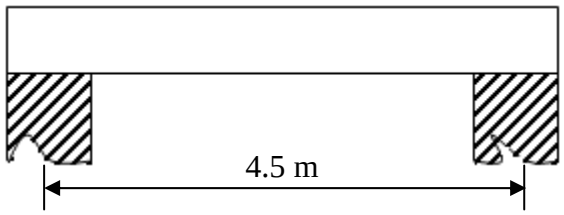


Figure 2.0

i. Calculate the area of bending reinforcement required.

[10 marks]

ii. Check the shear, end anchorage and amount of distribution steel required.

[4 marks]

b) Sketch the structural details of a continuous solid slabs with the simplified rules for curtailment of bars in slab spanning in one direction. Indicate the percentage and position of bars required.

[6 marks]

3. a) A reinforced concrete staircase is supported by beams at both end as shown in Figure 3.1 below. The platforms at both ends are connected in monolithic with the staircase. Design the staircase using concrete with grade 30 and steel reinforcement with grade 460. The imposed load and finishes are 4.0 kN/m^2 and 0.5 kN/m^2 respectively. Concrete cover is 25 mm.

[15 marks]

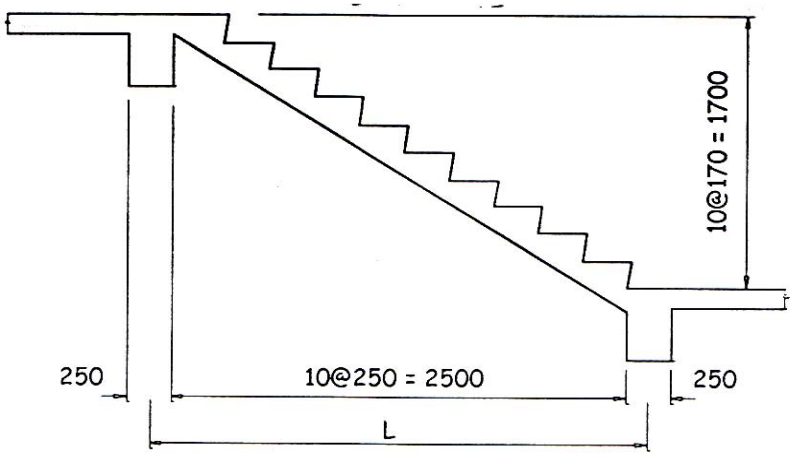


Figure 3.1

b) Determine the length of tension anchorage required for the 25 mm diameter plain mild steel reinforcing bars in the cantilever beam as shown in Figure 3.2. The characteristic materials strengths are f_{cu} = 30 N/mm^2 and f_y = 250 N/mm^2.

[5 marks]

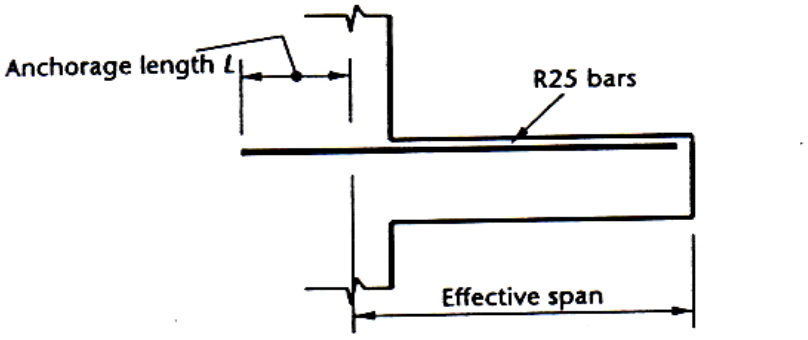


Figure 3.2

4. A four span continuous beam 300 mm breadth and overall depth of 500 mm, of span 5.0 m each, has the following characteristics:

Characteristic strength of concrete, f_{cu}	= 30 N/mm^2
Characteristic strength of high yield tensile steel, f_y	= 460 N/mm^2
Characteristic strength of hot rolled mild steel, f_y	= 250 N/mm^2
Diameter of main tension steel bar	= assume 25 mm ∅
Diameter of main compression steel bar	= assume 20 mm ∅
Diameter of shear link bar	= assume 10 mm ∅
Exposure condition	= moderate
Fire resistance	= 1.5 hrs
Nominal maximum aggregate size	= 20 mm
Dead load, g_k	= 20 kN/m
Impose load, q_k	= 10 kN/m

a) Determine the nominal cover suitable for the beam.

[4 marks]

b) Calculate the bending moments present in the beam when the maximum design ultimate load ($1.4\ g_k + 1.6\ q_k$) is used.

[6 marks]

c) Design the reinforcement suitable to resist the bending moments for first span of the beam, i.e. from outer support to the interior support.

[10 marks]

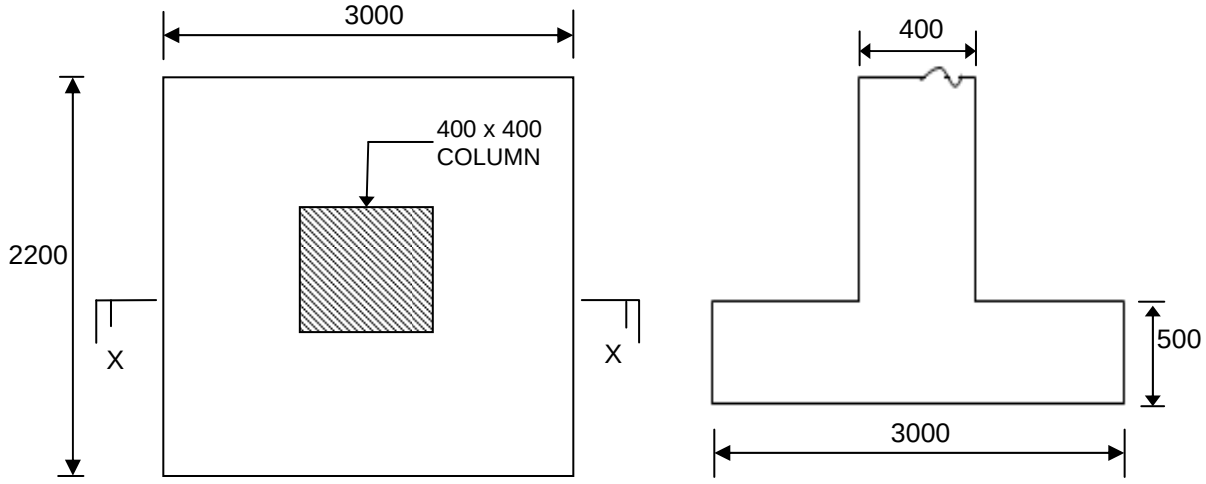
5. a) The need to provide combined footing is sometime unavoidable. With the aid of appropriate sketches, briefly discuss the **TWO (2)** conditions where combined footing is best suited.

[5 marks]

b) Design and provide complete detailing for the isolated pad footing as shown in Figure 5. The design parameters are as follows:-

Factored column load	= 1320 kN
Column size	= 400 mm x 400 mm
Concrete grade	= 35 N/mm^2
Diameter of main reinforcement	= 16 mm
Diameter of secondary reinforcement	= 12 mm
Characteristic strength of reinforcement	= 460 N/mm^2
Concrete cover	= 50 mm
Allowable soil bearing capacity	= 175 kN/m^2
z_i	= 0.95d_i

[15 marks]



(a) Plan (b) Plan

Figure 5 Plan and section of pad footing

6. a) The splice joint details between lower and upper floor column can be constructed using several arrangements. Briefly discuss **TWO (2)** types of the splice joint. Provide suitable sketches.

[6 marks]

b) Design and provide a typical cross section detailing of an unbraced slender column using the following information:-

Column size	= 400 mm x 400 mm
Column load at ultimate	= 3000 kN
Column effective length, l_e	= 6000 mm
Moment x-x (top)	= 72 kNm
Moment x-x (bottom)	= 36 kNm
Moment y-y (top)	= 66 kNm
Moment y-y (bottom)	= 32 kNm
Concrete grade	= 40 N/mm^2
Diameter of the main reinforcement	= 32 mm
Characteristic strength of main reinforcement	= 460 N.mm^2
Diameter of link reinforcement	= 10 mm
Characteristic strength of link reinforcement	= 250 N/mm^2
Concrete cover (excluding link)	= 20 mm

Assume K = 1 and the column bent in a double curvature shape.

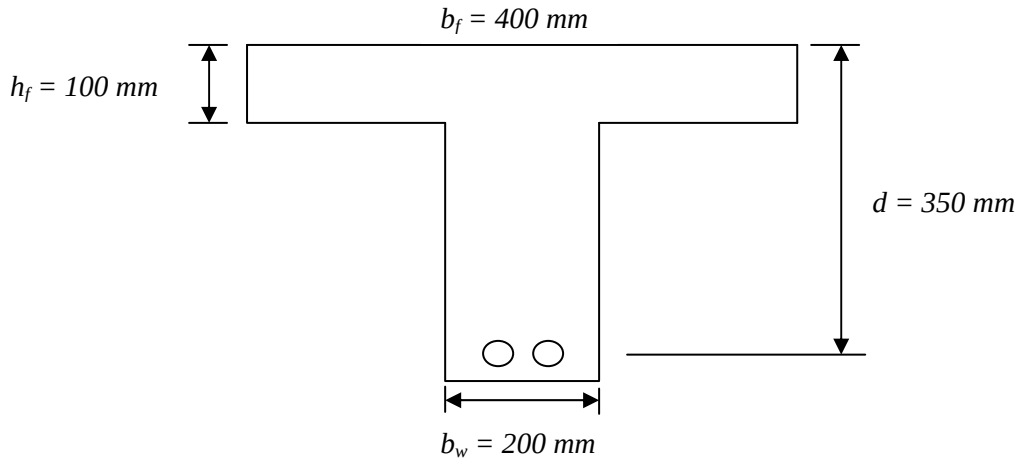
[14 marks]

1. a) *Dua prinsip keadaan had iaitu keadaan had muktamad (ULS) dan keadaan had kebolehkhidmatan (SLS). Terangkan dengan ringkas kedua-dua prinsip tersebut dalam rekabentuk konkrit bertulang.*

[6 markah]

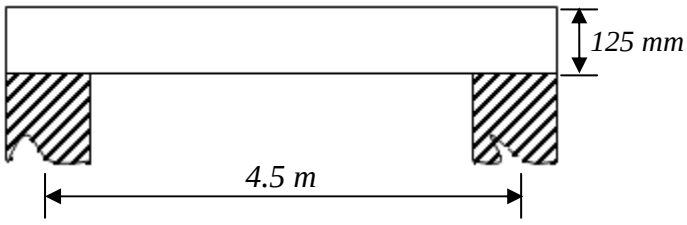
b) *Momen rekabentuk muktamat yang dirintangi oleh keratan –T seperti yang ditunjukkan dalam Rajah 1.0 ialah 200 kNm. Kekuatan ciri tetulang dan konkrit ialah f_y = 460 N/m^2 dan f_{cu} = 30 N/mm^2. Anggapkan kedalaman blok tegasan di bawah bebibir, kirakan luas tetulang tegangan yang diperlukan menggunakan kaedah blok tegasan segiempat di permudahkan.*

[14 markah]



Rajah 1.0

2. a) *Papak lantai konkrit di sokong mudah seperti yang ditunjukkan dalam Rajah 2.0 direkabentuk untuk membawa beban kenaan 3.5 kN/m^2, kemasan dan siling 1.0 kN/m^2, tidak termasuk berat sendiri papak. Kekuatan ciri bahan-bahan adalah f_{cu} = 30 N/mm^2 dan f_y = 460 N/mm^2. Anggapkan nisbah rentang-kedalaman berkesan ialah 20.*



Rajah 2.0

i. *Kirakan luas tetulang lenturan yang diperlukan.*

[6 markah]

ii. *Semak ricih, tambatan hujung dan jumlah keluli agihan yang diperlukan.*

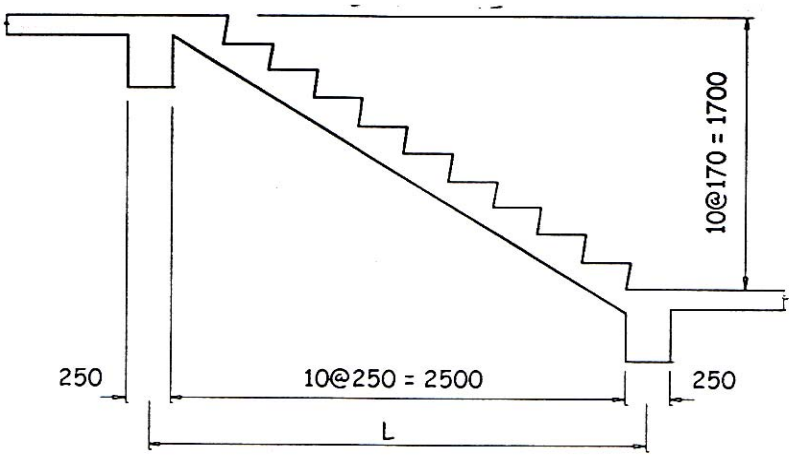
[8 markah]

b) *Lakarkan perincian struktur papak lantai selanjar menggunakan peraturan yang dipermudahkan untuk perincian tetulang dalam papak sehala. Tunjukkan peratusan dan kedalaman tetulang yang diperlukan.*

[6 markah]

3. a) *Sebuah tangga konkrit tetulang yang disokong oleh rasuk di kedua-dua hujungnya ditunjukkan dalam Rajah 3.1 di bawah. Pelantar di kedua-dua hujung bersambung secara monolitik dengan tangga. Rekabentuk tangga tersebut menggunakan konkrit gred 30 dan tetulang keluli gred 460. Beban kenaan adalah 4.0 kN/m^2 dan berat kemasan adalah 0.5 kN/m^2. Tebal penutup konkrit adalah 25 mm.*

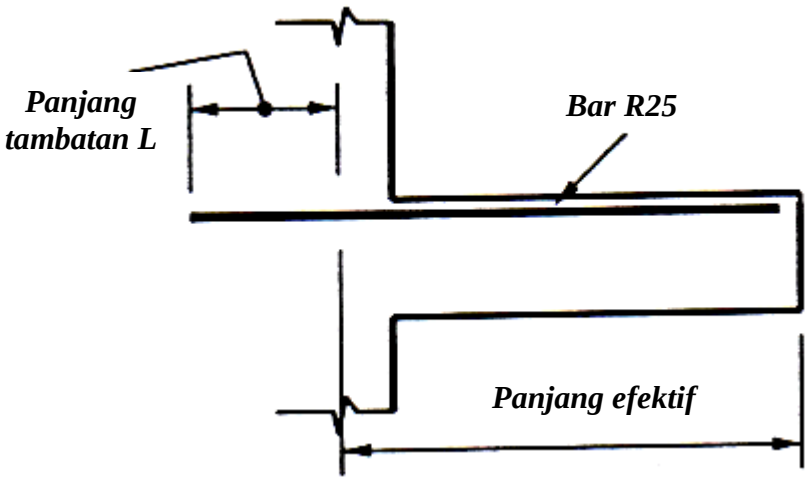
[15 markah]



Rajah 3.1

b) *Tentukan panjang tambatan tegangan yang diperlukan untuk tetulang keluli lembut bergarispusat 25 mm dalam rasuk julur seperti di Rajah 3.2. Kekuatan ciri bahan adalah f_{cu} = 30 N/mm^2 dan f_y = 250 N/mm^2.*

[5 markah]



Rajah 3.2

4. *Satu rasuk berterusan empat rentang, 300 mm lebar dan kedalaman keseluruhan 500 mm, rentang 5.0 m setiap satu, mempunyai ciri-ciri berikut:*

Ciri kekuatan konkrit, f_{cu}	*= 30 N/mm^2*
Ciri kekuatan keluli tepungan tinggi, f_y	*= 460 N/mm^2*
Ciri kekuatan keluli gelek paras, f_y	*= 250 N/mm^2*
Garispusat bar keluli tepangan utama	*= andai 25 mm ∅*
Garispusat bar keluli mampatan utama	*= andai 20 mm ∅*
Garispusat bar tetulang ricih	*= andai 10 mm ∅*
Keadaan di dalam	*= sederhana*
Rintangan api	*= 1.5 jam*
Saiz agregat maksima normal	*= 20 mm*
Beban mati, gk	*= 20 kN/m*
Beban kenaan, qk	*= 10 kN/m*

a) *Tentukan tutupan nominal sesuai untuk rasuk.*

[4 markah]

b) *Kira momen lentur yang ada di rasuk apabila beban maksima rekabentuk muktamad (1.4 g_k + 1.6 q_k) di gunakan.*

[6 markah]

c) *Rekabentuk tetulang yang sesuai untuk menahan momen lentur untuk rentang pertama rasuk, iaitu dari penyokong luar ke penyokong dalaman pertama.*

[10 markah]

5. a) *Keperluan menyediakan asas tergabung kadangkala tidak boleh dielakkan. Dengan bantuan lakaran yang sesuai, bincangkan dengan ringkas* ***DUA (2)*** *keadaan dimana asas tergabung paling sesuai digunakan.*

[5 markah]

b) *Rekabentuk dan sediakan perincian yang lengkap untuk asas pad seperti di Rajah 5. Parameter rekabentuk adalah seperti berikut:-*

Beban tiang muktamad	*= 1320 kN*
Saiz tiang	*= 400mm x 400mm*
Gred konkrit	*= 35 N/mm^2*
Garispusat tetulang utama	*= 16 mm*
Garispusat tetulang sekunder	*= 12 mm*
Kekuatan ciri tetulang	*= 460 N/mm^2*
Penutup konkrit	*= 50 mm*
Keupayaan galas tanah dibenarkan	*= 175 kN/m^2*
z_i	$= 0.95d_i$

[15 markah]

6. a) *Perincian sambungan sambat diantara tiang tingkat bawah dan atas boleh dibuat menggunakan beberapa susunan. Bincangkan dengan ringkas* ***DUA (2)*** *jenis perincian sambungan sambat tersebut. Sediakan lakaran yang sesuai.*

[6 markah]

b) *Rekabentuk dan sediakan perincian keratan tipikal tiang langsing tidak terembat dengan menggunakan maklumat-maklumat berikut:-*

Saiz tiang	*= 400 mm x 400 mm*
Beban muktamad tiang	*= 3000 kN*
Panjang berkesan tiang, l_e	*= 6000 mm*
Momen x-x (atas)	*= 72 kNm*
Momen x-x (bawah)	*= 36 kNm*
Moment y-y (atas)	*= 66 kNm*
Moment y-y (bawah)	*= 32 kNm*
Gred konkrit	*= 40 N/mm^2*
Garispusat tetulang utama	*= 32 mm*
Kekuatan ciri tetulang utama	*= 460 N/mm^2*
Garispusat tetulang rakap	*= 10 mm*
Kekuatan ciri tetulang rakap	*= 250 N/mm^2*
Penutup konkrit (tidak termasuk rakap)	*= 20 mm*

Anggap K = 1 dan tiang tersebut melentur dalam bentuk dwi-lengkungan.

[14 markah]

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