First Semester Examination
Academic Session 2018/2019

December 2018/January 2019

EAS353 – Reinforced Concrete Structural Design I
(Rekabentuk Konkrit Bertetulang I)

Duration : 2 hours
(Masa : 2 jam)

Please check that this examination paper consists of **NINE (9)** pages of printed material including appendix before you begin the examination.

*[Sila pastikan bahawa kertas peperiksaan ini mengandungi **SEMBILAN (9)** muka surat yang bercetak termasuk lampiran sebelum anda memulakan peperiksaan ini.]*

Instructions: This paper consists of **FIVE (5)** questions. Answer **FOUR (4)** questions.

*[**Arahan:** Kertas ini mengandungi **LIMA (5)** soalan. Jawab **EMPAT (4)** soalan.]*

In the event of any discrepancies, the English version shall be used.

[Sekiranya terdapat sebarang percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah digunapakai.]

(1). A continuous beam shown in **Figure 1** has a constant cross section and supports a uniformly distributed permanent action including its self-weight of 20 kN/m and a variable action of 10 kN/m. The cross section of beam at mid-span is 200 mm width by 300 mm depth and reinforced by 3H16 of tension and 2H12 of compression reinforcements. The concrete cover for the beam is 30 mm. The yield strength of the steel reinforcement and compressive strength of concrete are 500 N/mm^2 and 30 N/mm^2, respectively.

*Sebuah rasuk selanjar seperti ditunjukkan dalam **Rajah 1** mempunyai keratan rentas seragam dan menyokong beban teragih seragam tindakan kekal sebanyak 20 kN/m termasuk berat-diri dan tindakan boleh ubah sebanyak 10 kN/m. Keratan rentas di pertengahan rentang rasuk ialah 200 mm lebar dan kedalaman 300 mm mempunyai 3H16 tetulang tegangan dan 2H12 tetulang mampatan. Pelindung konkrit untuk tetulang adalah 30 mm. Lebar rasuk ialah 200 mm. Tegasan alah besi tetulang dan kekuatan mampatan konkrit masing-masing ialah 500 N/mm^2 and 30 N/mm^2.*

(a). Sketch three load arrangements recommended for buildings in accordance with BS EN 1992-1-1:2004+A1:2014. Calculate the load combinations considered for the load arrangement.

Lakarkan tiga susun atur beban yang disyorkan untuk bangunan berdasarkan BS EN 1992-1-1:2004+A1:2014. Kira beban gabung yang diambil kira untuk susun atur beban tersebut.

[5 marks/*markah*]

(b). Sketch the cross section of the beam as described in this question.
Lakarkan keratan rentas rasuk seperti dinyatakan dalam soalan ini.

[3 marks/*markah*]

(c). Sketch an equivalent rectangular stress block for the cross-section sketched in Question 1(b). The tensile and compressive forces on the section are in equilibrium. Determine the compressive force in concrete and compression reinforcement, and tensile force in tension reinforcement.

Lakarkan satu blok tegasan segiempat setara untuk keratan rentas rasuk yang telah dilakar dalam Soalan 1(b). Daya tegangan dan mampatan di keratan tersebut adalah dalam keseimbangan. Tentukan daya mampatan dalam konkrit dan tetulang mampatan, dan daya tegangan dalam tetulang tegangan.

[8 marks/*markah*]

(d). Determine the ultimate moment of resistance of the cross section sketched in Question 1(b). Ignore the compression reinforcement steel.

Tentukan momen rintangan muktamad keratan rentas yang telah dilakar dalam Soalan 1(b). Abaikan besi tetulang mampatan.

[9 marks/*markah*]

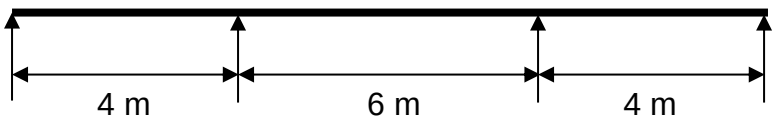


Figure 1/*Rajah 1*

(2). A slab for an affordable housing system is designed to be 220 mm thick and spans in two directions. The effective span in each direction is 4.5 m and 6.0 m. The slab supports a variable action of 10 kN/m^2. The characteristic material strengths are f_{ck} = 25 N/mm^2 and f_{yk} = 500 N/mm^2 .Design this simply supported slab. Given,

Sebuah papak untuk sistem perumahan mampu milik direkabentuk untuk menjadi 220 mm tebal dan rentang dalam dua arah. Rentang efektif pada setiap arah adalah 4.5 m dan 6.0 m. Papak menyokong beban bolehubah 10 kN/m^2. Kekuatan ciri bahan adalah f_{ck} = 25 N/mm^2 dan f_{yk} = 500 N/mm^2. Reka bentuk papak disokong mudah ini. Diberikan,

The slab is in class XC-1 exposure conditions,
Papak adalah dalam keadaan dedahan kelas XC-1,

Nominal concrete cover, Cnom =30 mm,
Penutup konkrit nominal, Cnom =30 mm,

Assume diameter of bar = 10 mm
Anggap diameter bar = 10 mm

[25 marks/*markah*]

(3). A simply supported beam as shown in **Figure 2** has a cross section A-A supports uniformly distributed permanent actions (g_k) excluding it's self-weight of 10 kN/m and a variable action (q_k) of 5 kN/m. Design and provide the detailing for the beam. Take characteristic compressive strength of concrete, f_{ck}=35 N/mm^2, characteristic strength of reinforcement, f_{yk}=500 N/mm^2, diameter of main bar, ϕ =20 mm, diameter of links, ϕ'=8 mm and concrete cover, c=25 mm. Ignore the shear check for the beam and take self-weight of the beam as 20 kN.

*Sebuah rasuk disokong mudah seperti pada **Rajah 2** mempunyai keratan rentas A-A, menyokong beban teragih seragam tindakan kekal (g_k) tidak bermasuk berat diri sebanyak 10 kN/m dan tindakan boleh ubah (q_k) sebanyak 5 kN/m. Rekabentuk dan sediakan perincian keratan untuk rasuk tersebut. Ambil kekuatan mampatan ciri konkrit, f_{ck}=35 N/mm^2, kekuatan ciri besi tetulang, f_{yk}=500 N/mm^2, diameter tetulang utama, ϕ=20 mm, diameter tetulang penyambung, ϕ'=8 mm dan penutup konkrit, c=25 mm. Abaikan semakan ricih untuk rasuk berkenaan dan ambil berat diri rasuk sebagai 20 kN.*

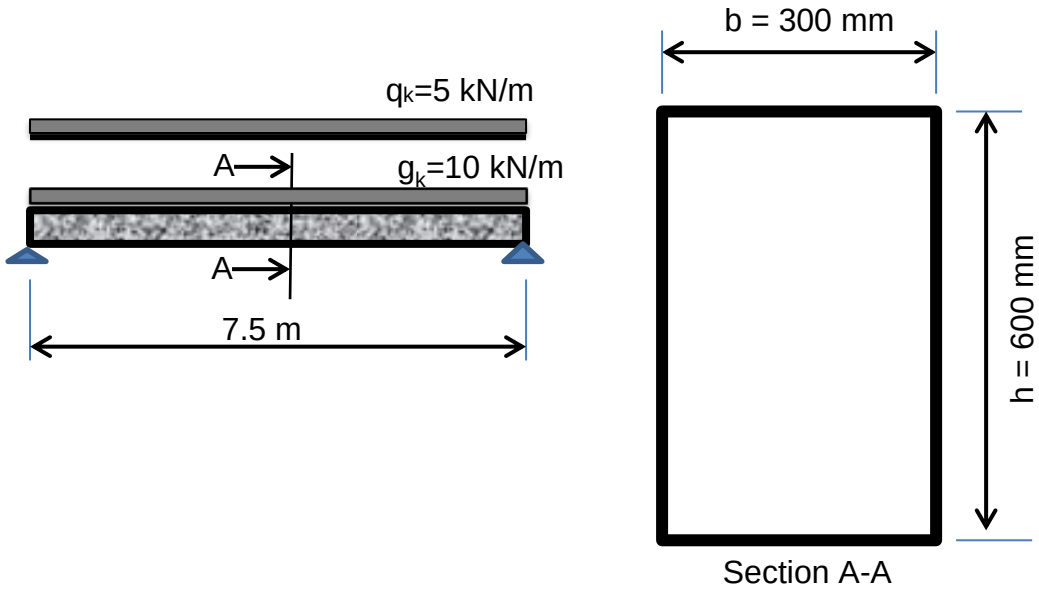


Figure 2/*Rajah 2*

[25 marks/*markah*]

(4). An internal column has a cross section of 300 mm x 300 mm. The column is subjected to an axial load of 1600 kN and bending moment, M of 60 kNm including the effect of imperfections. Design the column with assistance of the Design Chart in the **APPENDIX** by assuming the following information:

Sebuah tiang dalaman mempunyai keratan rentas 300 mm x 300 mm. Tiang berkenaan dikenakan beban tindakan paksi sebanyak 1600 kN dan momen lentur, M adalah 60 kNm termasuk kesan ketidaksempurnaan. Rekabentuk tiang tersebut dengan bantuan Carta Rekabentuk pada ***LAMPIRAN*** *dengan mengambilkira maklumat berikut:*

(a). Characteristic compressive strength of concrete, f_{ck}=35 N/mm^2

Kekuatan mampatan ciri konkrit, f_{ck}=35 N/mm^2

(b). Characteristic strength of reinforcement, f_{yk}=500 N/mm^2

Kekuatan ciri besi tetulang, f_{yk}=500 N/mm^2

(c). Diameter of main bar, ϕ =25 mm

Diameter tetulang utama, ϕ =25 mm

(d). Diameter of links, ϕ' =8 mm

Diameter tetulang penyambung, ϕ'=8 mm

(e). Concrete cover, c =30 mm

Penutup konkrit, c =30 mm

(f). Effective height, l_o =3.8 m

Ketinggian efektif, l_o =3.8 m

[25 marks/*markah*]

(5). (a). The part plan of the column layout for a community hall project is shown in **Figure 3**. The structural analysis showed that column 2/B supports service load G_k = 300 kN and Q_k = 80 kN. If the allowable bearing pressure of the soil is 150 kN/m^2, design a rectangular pad footing at gridline 2/B based on the maximum bending moment only. In order to avoid overlapping, the length and the width of the pad footing shall not exceed 2.8 m and 1.0 m, respectively. Take the concrete grade, f_{ck} = 30 N/mm^2, the overall depth of the footing, h = 400 mm, reinforcement size = 12 mm and z = 0.95d.

*Sebahagian pelan susunatur tiang untuk projek dewan komuniti ditunjukkan di **Rajah 3**. Analisis struktur menunjukkan tiang 2/B menanggung beban kebolehkhidmatan G_k = 300 kN and Q_k = 80 kN. Jika tekanan galas tanah dibenarkan adalah 150 kN/m^2, rekabentuk satu asas pad berbentuk segiempat tepat pada garisan grid 2/B berdasarkan momen maksimum sahaja. Untuk mengelakkan pertindihan, panjang dan lebar asas pad masing-masing tidak boleh melebihi 2.8 m dan 1.0 m. Ambil gred konkrit f_{ck} = 30 N/mm^2, kedalaman keseluruhan asas, h = 400 mm, saiz tetulang = 12 mm dan z = 0.95d.*

[20 marks/*markah*]

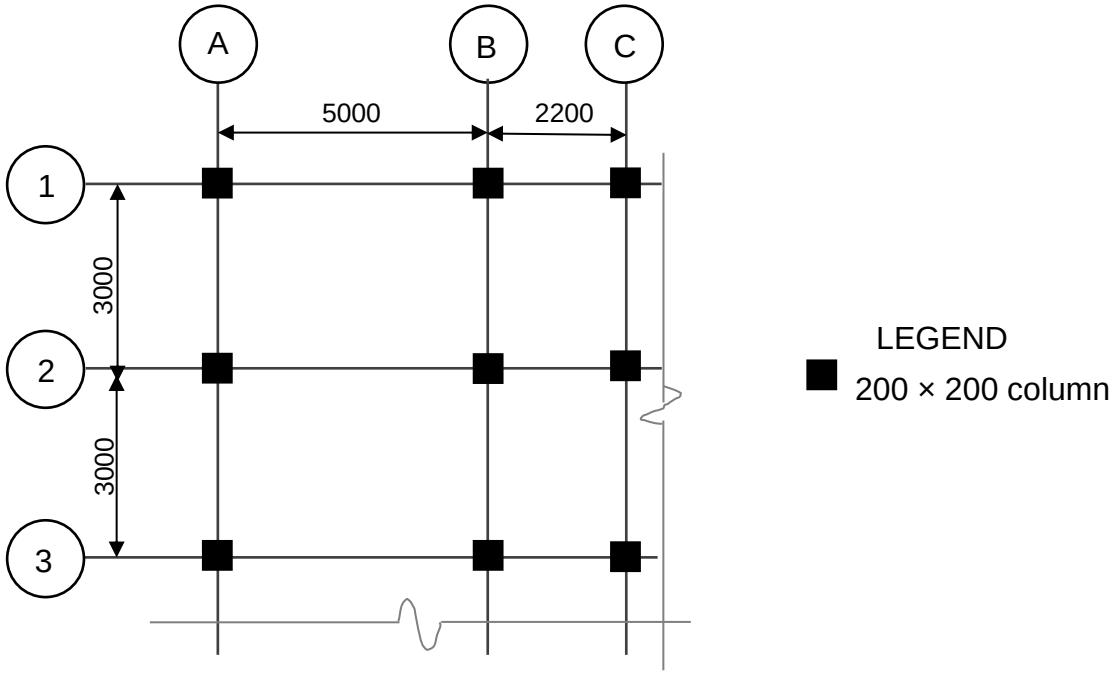


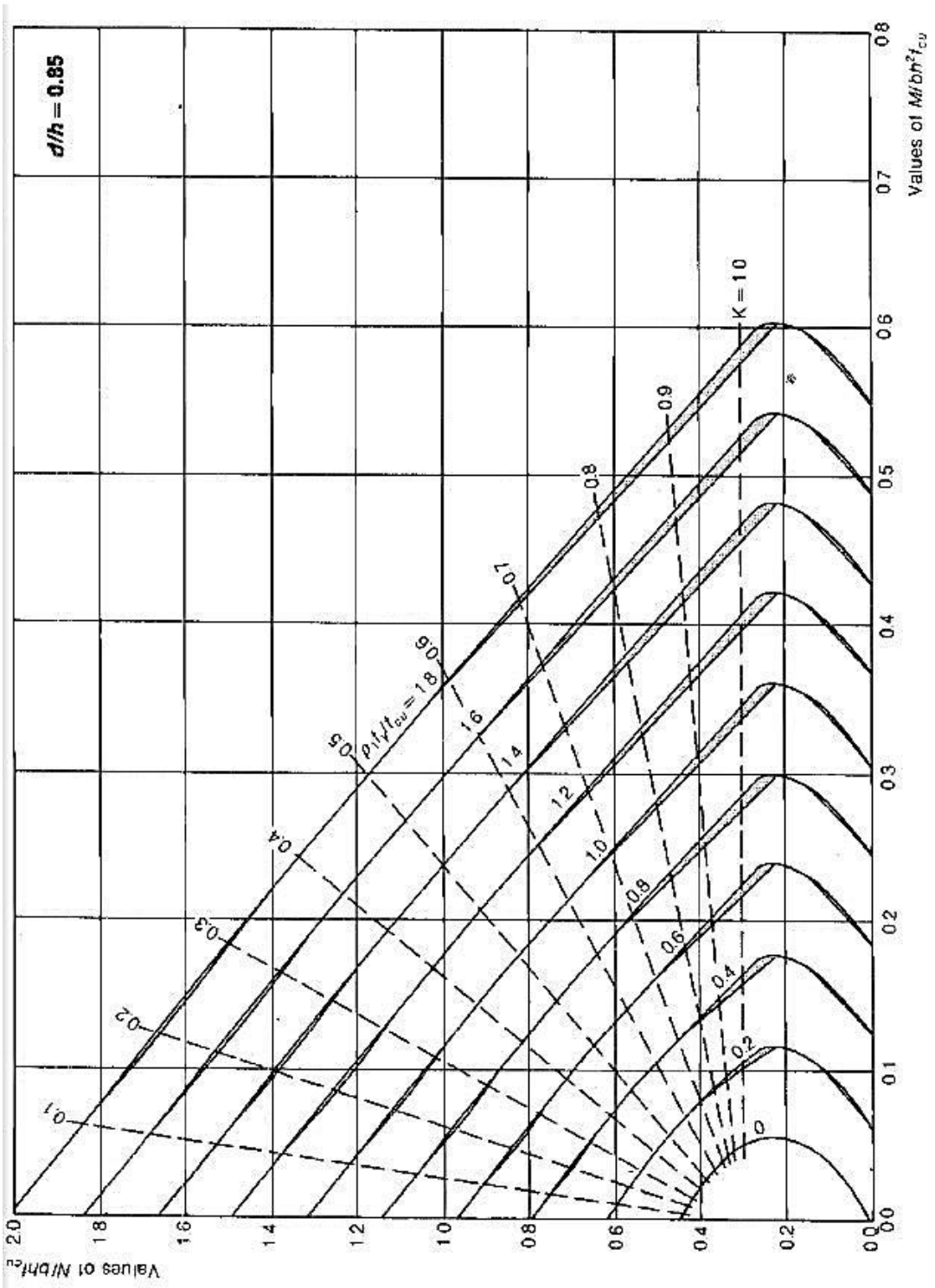
Figure 3 (all dimensions in mm)/*Rajah 3 (semua ukuran dalam mm)*

(b). Provide full detailing for the pad foundation. Assume H12@125 mm centre to centre as the reinforcement to resist the minimum bending moment.

Sediakan perincian penuh asas pad tersebut. Anggap H12@125 mm jarak pusat ke pusat sebagai tetulang yang merintang momen lentur minimum.

[5 marks/*markah*]

APPENDIX/ *LAMPIRAN*



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