

SULIT



First Semester Examination
2021/2022 Academic Session

February/March 2022

EAS353 – Reinforced Concrete Structural Design I

Duration : 2 hours

Please ensure that this examination paper contains **NINE (9)** printed pages including appendix before you begin the examination.

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

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

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1. (a). **Figure 1** shows the cross-section of a beam with the tension and compression reinforcement. The ratio of d'/d is limited to 0.171 for the yielding of steel reinforcement bar with $f_{yk} = 500 \text{ N/mm}^2$ and concrete class $< \text{C50/60}$. The maximum compressive strain (ϵ_{cu2}) and the depth of the neutral axis in the concrete class considered are taken as 0.0035 and $0.45d$, respectively. Show that the d'/d is less than 0.171.

[5 marks]

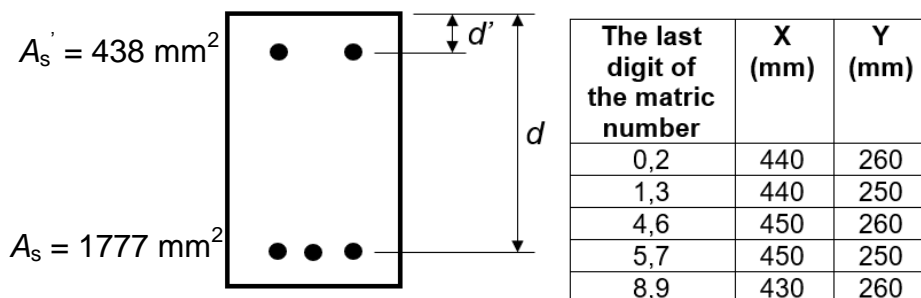
- (b). The cross-section shown in **Figure 1** is to resist an ultimate design moment. The characteristic strengths are 500 N/mm^2 for reinforcement and 30 N/mm^2 for the concrete. The effective depth and width of a beam are $X \text{ mm}$ and $Y \text{ mm}$, respectively. Use $d' = 50 \text{ mm}$.

- (i) Draw an equivalent rectangular stress block for the cross-section. Show clearly the depth of stress block, design concrete strength, compressive force in the concrete and steel, and the tensile force in the steel.

[2 marks]

- (ii) Determine the ultimate moment of resistance of the cross-section.

[8 marks]



Example: * Matric number = 50078, Use $X = 430 \text{ mm}$ and $Y = 260 \text{ mm}$

Figure 1

(c). The T-section shown in **Figure 2** is required to resist an ultimate design moment. The characteristic strengths are 500 N/mm^2 for reinforcement and 25 N/mm^2 for the concrete. The depth and width of the flange are 150 mm and 800 mm , respectively. The effective depth of the beam is 440 mm . Assume that the stress block depth lies within the flange. Use the value of A_s as tabulated in **Table 1**

(i). Draw an equivalent rectangular stress block for the cross-section of the T-beam. Show the design concrete strength, compressive force in the concrete, and the tensile force in the steel and depth of stress block.

[2 marks]

(ii). Determine the ultimate moment of resistance of the T-beam section.

[8 marks]

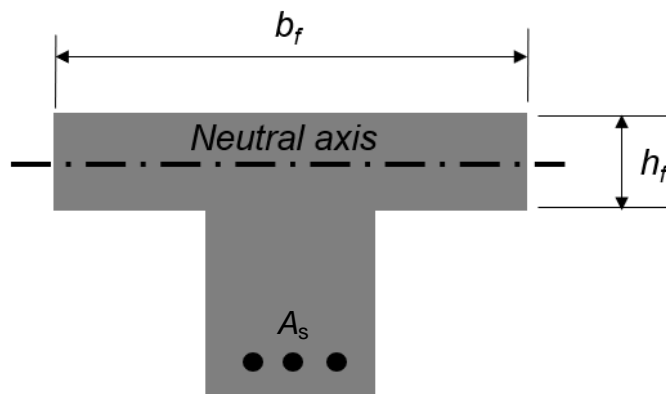


Figure 2

Table 1

The last digit of the matric number	0,1	2,3	4,5	6,7	8,9
$A_s \text{ (mm}^2\text{)}$	1470	1960	1260	1610	1030

Example: * Matric number = 50075, Use $A_s = 1260 \text{ mm}^2$

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2. **Figure 3** shows the ground floor structural plan of a reinforced concrete residential building. During construction, slabs and beams are cast together. The characteristic strength of concrete, $f_{ck} = 25 \text{ N/mm}^2$ and characteristic strength of reinforcement, $f_{yk} = 500 \text{ N/mm}^2$. Based on the information provided, design and provide detailing for slab panel B-C/2-3.

Given;

The characteristic actions:

Permanent load, $g_k = 1.50 \text{ kN/m}^2$ (Excluding selfweight)

Variable load, $q_k = 1.50 \text{ kN/m}^2$

Assume;

Bar diameter = 10 mm

Nominal cover = 30 mm

Assume the required data for the design. Provide comments for your findings.

[25 marks]

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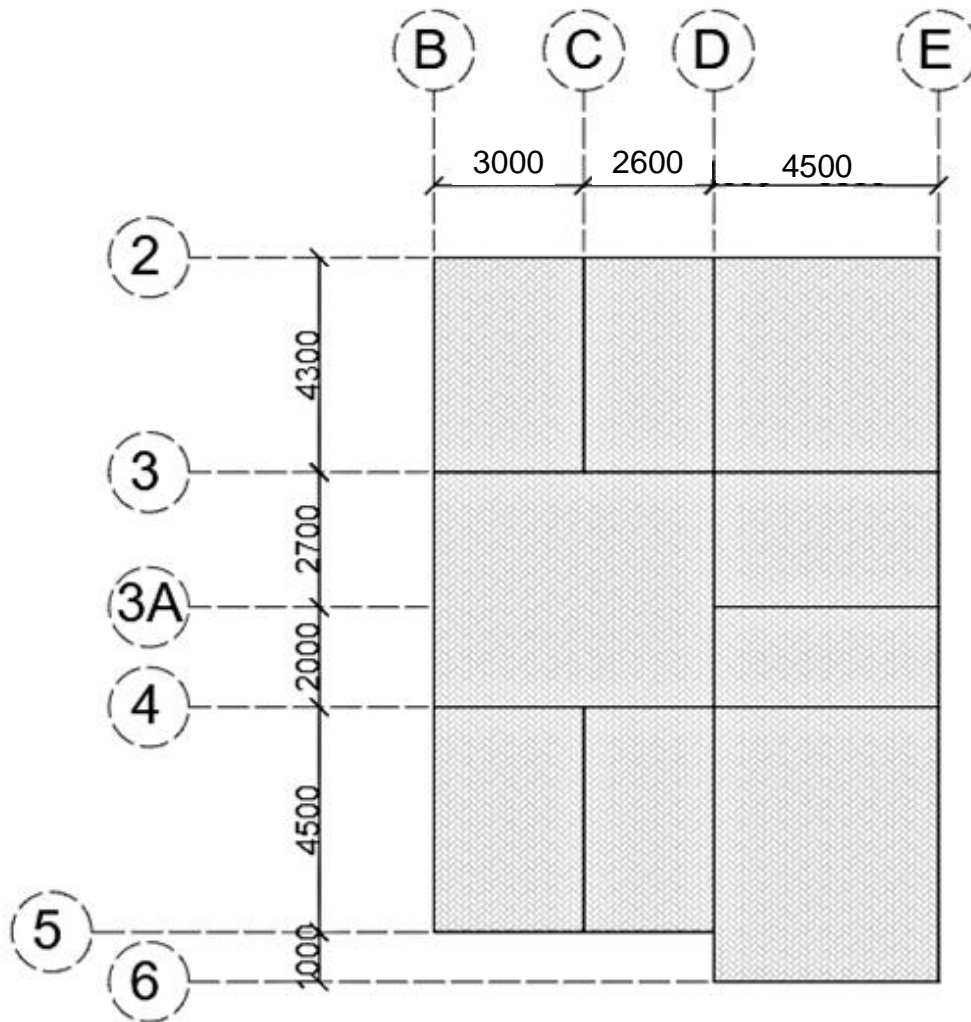
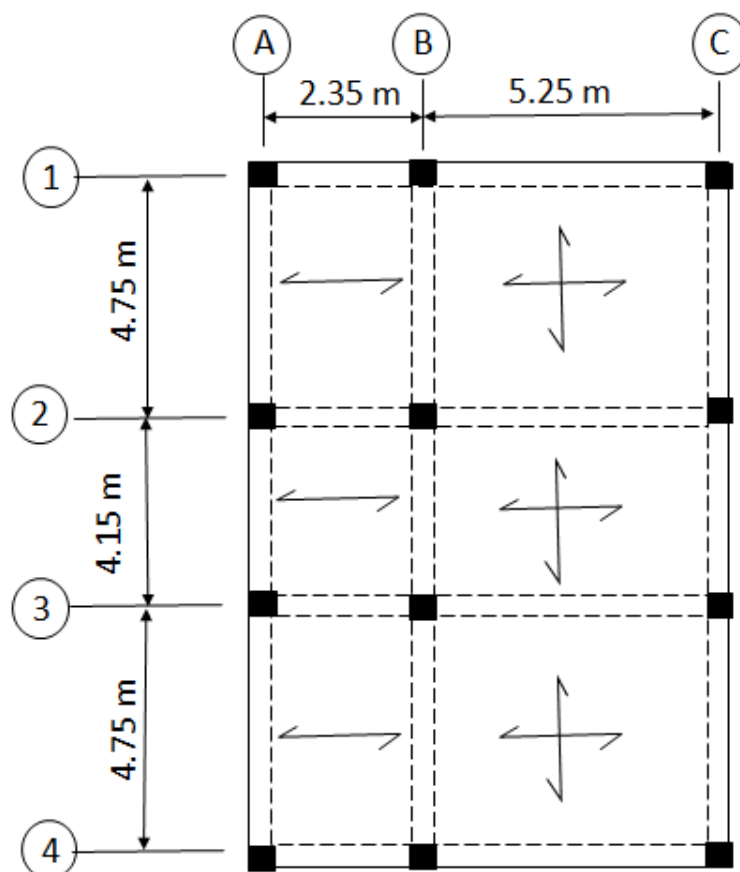


Figure 3 (All dimensions are in mm)

3. **Figure 4** shows the key plan of a RC floor. The slabs are classified as one and two-way slabs as shown in the figure. The following data is given:

Variable load	= 3.5 kN/m ²
Finishing	= 1.0 kN/m ²
Slab thickness	= 150 mm
f_{ck}	= 30 N/mm ²
f_{yk}	= 500 N/mm ²
Size of beam	= 225 × 450 mm (A/1-4, C/1-4)
	= 225 × 600 mm (B/1-4)
Cover	= 25 mm



*: Dimension of span shown is effective span

Figure 4

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For span 1-2 of the continuous beam A/1-4,

- Design the flexural reinforcement for sagging and hogging bending moments
- Design the shear reinforcement based on shear force at support 2
- Check for deflection
- Sketch of the reinforcement detailing

Use the following sizes of reinforcement:

- mid-span : H12
- support : H16
- shear link : H8

[25 marks]

4. An internal column with a cross section of 350 mm × 450 mm is subjected to 3000 kN axial load and bending moment about its major axis as shown in **Figure 5**. The column is classified as braced and non-slender. Design and provide the cross-sectional detailing of the column considering the concrete compressive strength, $f_{ck} = 30 \text{ N/mm}^2$, yield strength of reinforcement, $f_{yk} = 500 \text{ N/mm}^2$, effective length, $l_o = 3200 \text{ mm}$ and concrete cover = 30 mm. Use H20 mm and H8 mm as the main reinforcement and link, respectively. The design chart is provided in **APPENDIX 1**.

[25 marks]

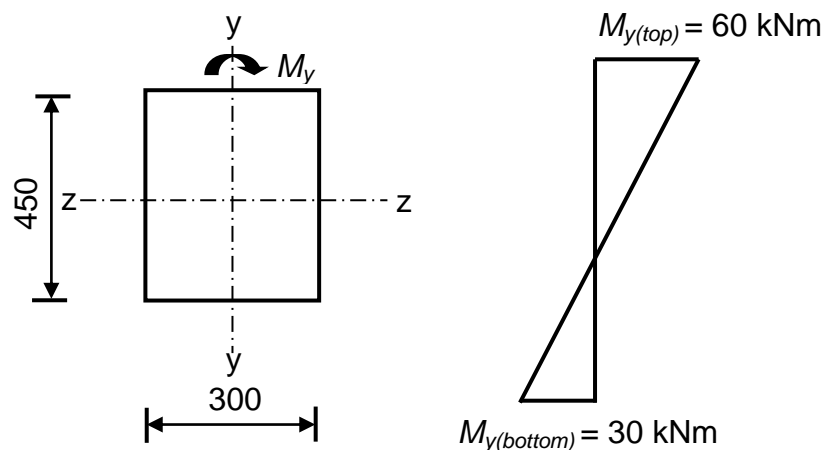


Figure 5 (All dimensions are in mm)

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5. The plan of a rectangular footing supporting a single 300 mm × 500 mm column is shown in **Figure 6**. The footing is required to support factored design load $G_k = 900$ kN and $Q_k = 250$ kN. If the allowable bearing pressure of the soil is 250 kN/m², design and provide the complete detailing of the footing. Take the concrete grade, $f_{ck} = 30$ N/mm², the overall depth of the footing, $h = 400$ mm and concrete cover = 50 mm. Use reinforcement size = 16 mm and 12 mm for the maximum and minimum moment, respectively. Ignore the shear check at the column face and reinforcement spacing.

[25 marks]

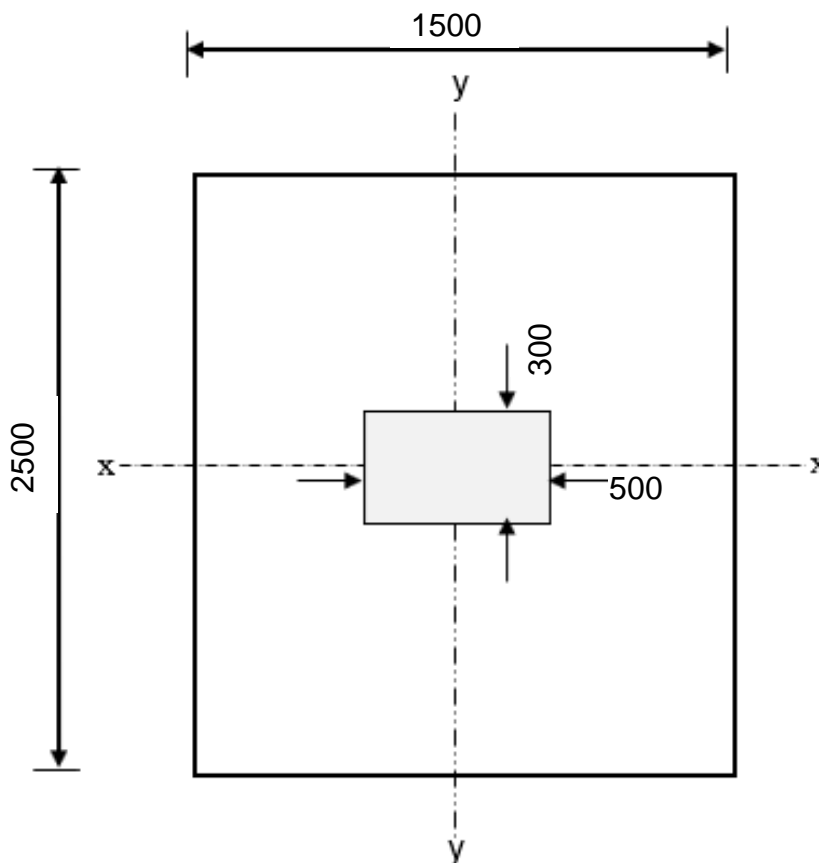
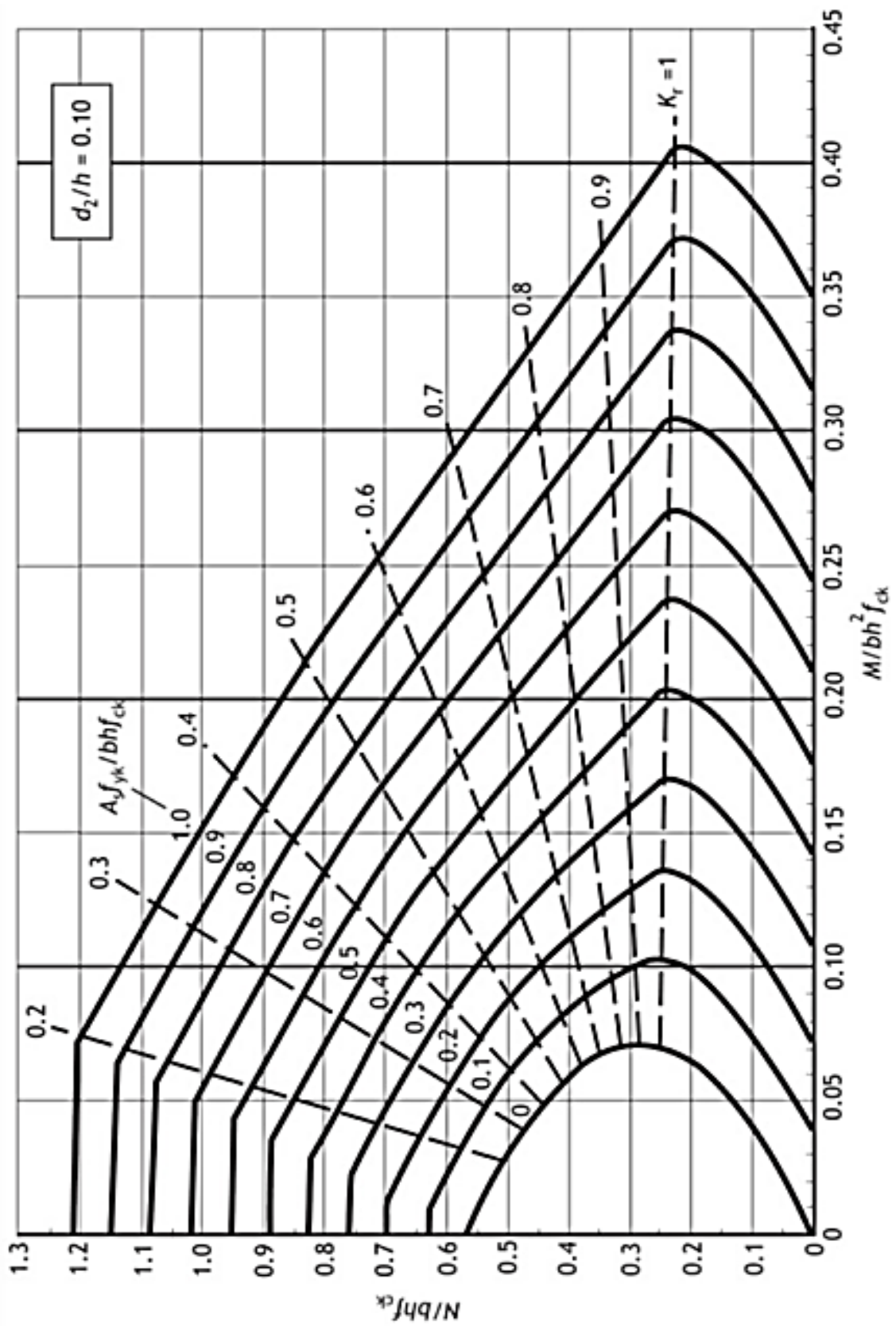


Figure 6 (All dimensions are in mm)

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APPENDIX 1



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