



First Semester Examination
Academic Session 2019/2020

December 2019/January 2020

EAS664 – Principle of Structural Design

Duration : 2 hours

Please check that this examination paper consists of **SEVEN (7)** pages of printed material before you begin the examination.

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

All questions must be answered in English.

Each question **MUST BE** answered on a new page.

- (1). (a). Discuss briefly the advantages and disadvantages of yield line over linear elastic analysis.
[5 marks]
- (b). Explain the yield line analysis procedure.
[5 marks]
- (c). Explain any **FIVE (5)** rules for constructing yield lines pattern.
[5 marks]
- (d). In a plastic design theory for steel structures, moment-rotation characteristics of general cross section is important. With sketches, explain the concept of moment-rotation characteristics for general cross section.
[10 marks]

- (2). The slab in **Figure 1** is subjected to a load of 11 kN/m^2 . The left-hand edge is fixed, whereas the right-hand edge is elastically restrained so that the support moment is lower. Assume a non-symmetrical pattern of lines of zero shear force as shown in **Figure 1**. Calculate the design moments for elements 1, 2, 3, and 4 and draw the resultant distribution of design moments in the given slab. Use Hillerborg Strip method.

[25 marks]

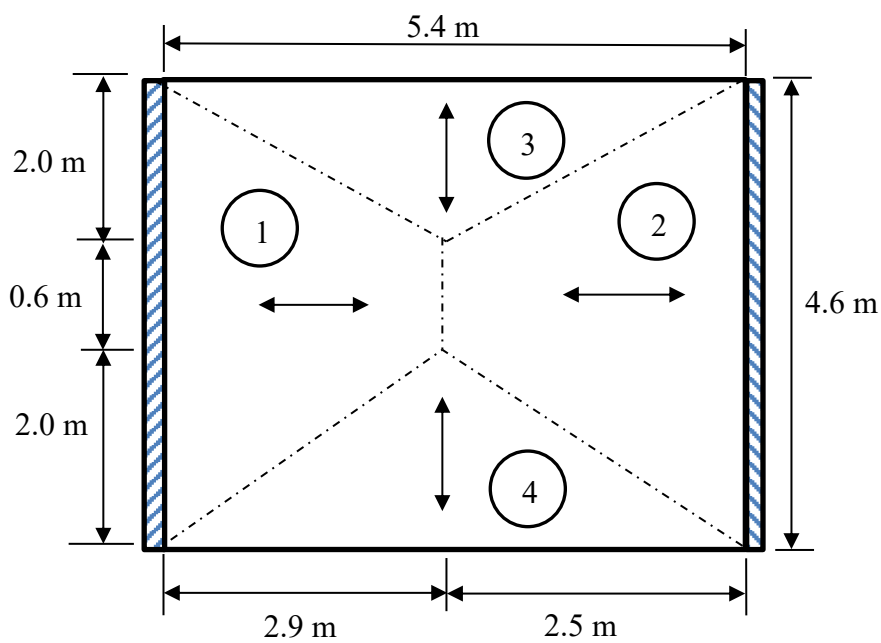


Figure 1

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- (3). (a). A 20-storey rigid frame building with setback as shown in **Figure 2** is located in Zone 1 with terrain category 2. The interstorey height is 3 m and the frames are spaced at 8 m. The width of the building is 24 m. Estimate the value of the design wind pressure on the wind ward direction, W at the top floor of the frame according to MS1553:2002. Indicate all assumed values used in the calculations. Design data can be extracted from MS1553 (2002).

[17 marks]

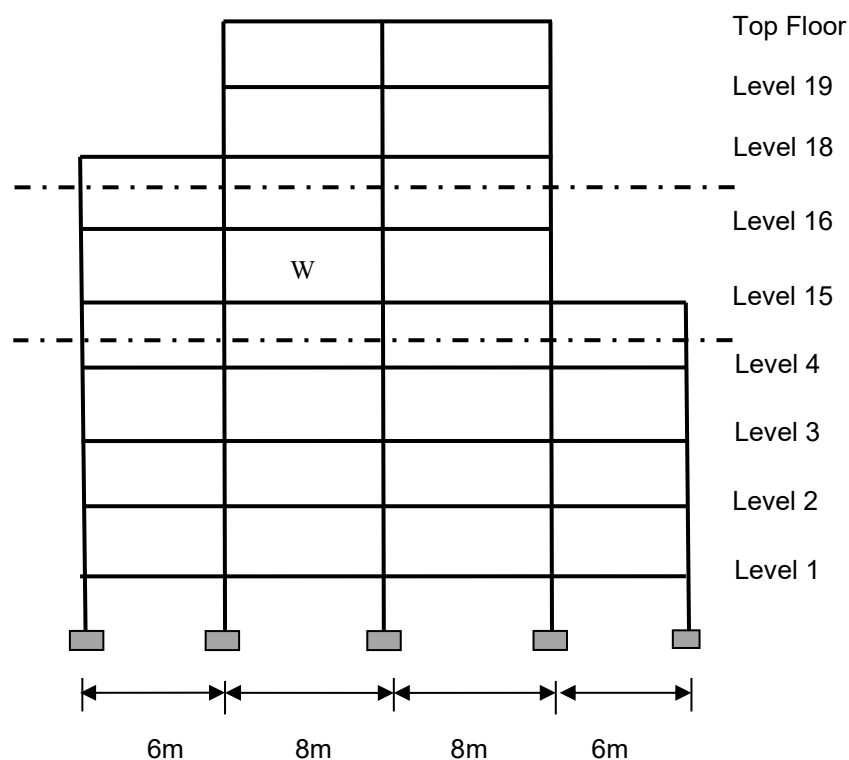


Figure 2

- (b). Discuss (i) Braced frame structures, (ii) Infilled frame structures, (iii) Flat-plate and flat-slab structures and (iv) Waffle flat slabs, as structural forms and floor systems in a high-rise building.

[8 marks]

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- (4). (a). State the seismic design philosophy under performance based earthquake engineering for structures other than essential facilities.

[4 marks]

- (b). Moment framed buildings can be categorised as Ordinary, Intermediate and Special Moment Resisting Frames. Discuss their applicability, detailing requirement, advantages and disadvantages.

[6 marks]

- (c). **Figure 3** shows a reinforced concrete shear wall building. The beams are 225 mm wide by 275 mm deep. The column sections are 300 mm by 300 mm. The dead load per unit area of floor slabs (150 mm thick) including screeding and plastering is 4.5 kN/m^2 . Assume full height brickwall of 115 mm thick is constructed on the beams from the ground to the fourth floor. The density of reinforced concrete and brickwall are 24 kN/m^3 and 18 kN/m^3 , respectively. The building has 5% damping and it is designed for Ductility Class Medium (DCM). The peak ground acceleration at the site is $0.16g$. The land is of high intensity characterized by earthquake with a surface wave magnitude of 6.5. The soil profile at the site is given in **Figure 4**. Determine the seismic forces for Frame A-A in accordance with EC8.

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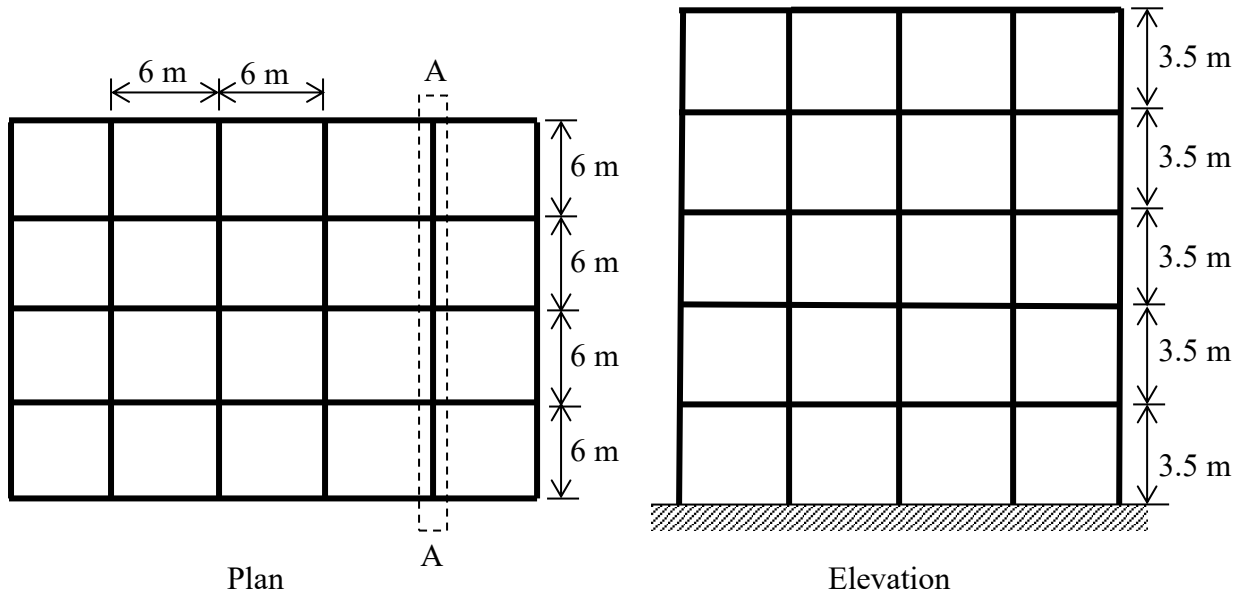


Figure 3

$V_{S1} = 75 \text{ m/s}$ $H_1 = 8 \text{ m}$
$V_{S2} = 120 \text{ m/s}$ $H_2 = 10 \text{ m}$
$V_{S3} = 230 \text{ m/s}$ $H_3 = 4 \text{ m}$
$V_{S4} = 125 \text{ m/s}$ $H_4 = 20 \text{ m}$

Figure 4

[15 marks]

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(5). (a). Describe **THREE (3)** important roles of floor systems in a tall building. [3 marks]

(b). A subframe of eight storey rigid frame has experienced an equivalent horizontal force as shown in **Figure 5**. The storey height is typically 3.0 m, to give a total height of 24 m. The frames are spaced at 9 m. Using the Portal Method, calculate:

- (i). The horizontal external shear at mid-storey level for each storey.
- (ii). The shear to half-columns above and below fifth storey.
- (iii). The maximum moment above and below joint at fifth storey.
- (iv). The shear in the girder at fifth storey.

Indicate all values (i – iv) on a diagram.

[18 marks]

(c). What are the main differences between Portal Method and Cantilever Method in determining member forces caused by horizontal loading in a tall building?

[4 marks]

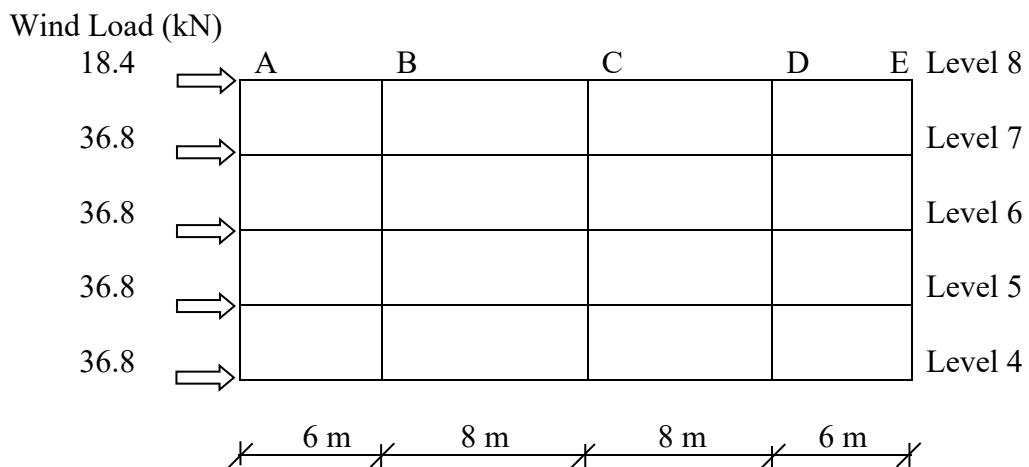


Figure 5

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