UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session 2009/2010

November 2009

EAS 664/4 – Principle Of Structural Design

Duration : 3 hours

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

Instructions: This paper contains **SIX (6)** questions. Answer **FIVE (5)** questions only.

All question should be answered in English.

Each question carry equal marks.

All question **MUST BE** answered on a new sheet.

Write the answered question numbers on the cover sheet of the answer script.

1. a) Briefly describe **FIVE (5)** factors influence the wind load calculation in code of practices.

(5 marks)

b) Ten-storey steel frames as shown in Figure 1 reflects the terrain category 3 in Seremban with the basic wind speed of 33.5 m/s. Calculate the value of the design wind force at fifth floor and roof levels of the frame according to MS1553:2002. The storey height is typically 3.0 m, to give a total height of 24m. The frames are spaced at 8m, the width of building is 30m and the length is 40m. Please indicate all assumed values used in the calculations.

(15 marks)

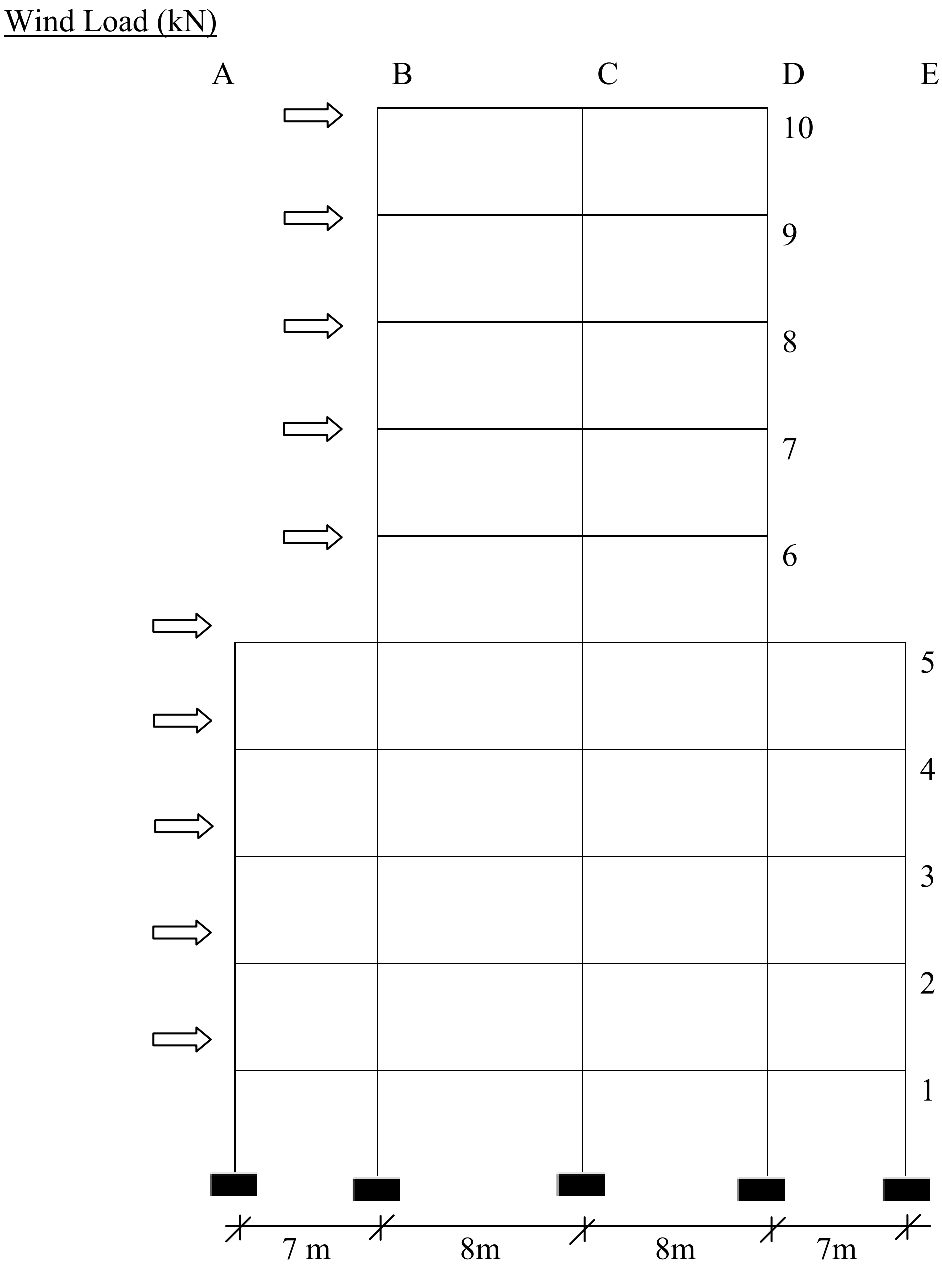

Figure 1

2 a) Briefly describe **TWO (2)** structural forms and **TWO(2)** reinforced concrete floor systems in a high-rise building in the form of sketches.

(8 marks)

b) A subframe of ten storey rigid frames has experienced an equivalent horizontal force as shown in Figure 2. The storey height is typically 3.0 m, to give a total height of 30m. The frames are spaced at 9m. Using the Portal Method, calculate :

i) The horizontal external shear at mid-storey level for fourth and fifth storey.

ii) The shear to half-columns above and below of 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 the diagram.

(8 marks)

c) List **TWO (2)** advantages of Portal Method in determining the member forces caused by horizontal loading.

(4 marks)

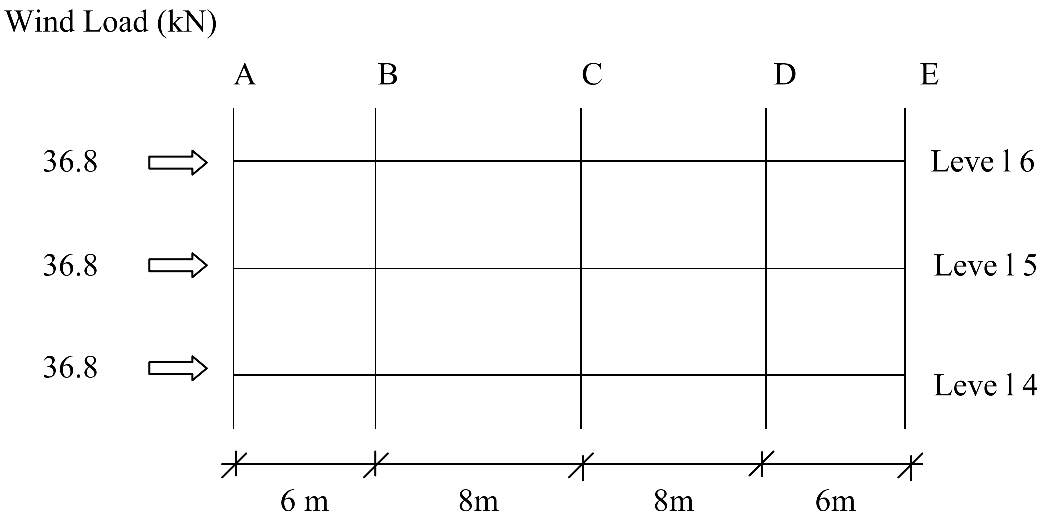

Figure 2

3. a) Explain the lateral torsional buckling behaviour on steel I beam. How to prevent this behaviour happen through the several options.

(10 marks)

b) Derive the warping constant equation of an I beam steel section. How this warping constant influence the lateral torsional buckling behavior of I-beam Steel Section.

(10 marks)

4. a) Figure 3 shows the I-beam section with the dimensions. Please calculate **FIVE (5)** of the section properties for the section.

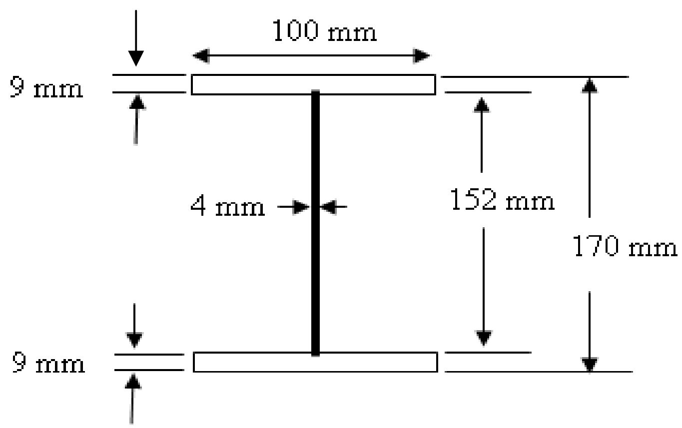

Figure 3

(10 marks)

b) From the section properties above, discuss what are the major factors that effect the lateral torsional buckling behaviour of the I-beam section.

(10 marks)

5. a) With the aid of a suitable sketch, briefly discuss the basic description of the Strut-and-Tie Model.

(5 marks)

b) A simply supported reinforced concrete deep beam carrying equal point loads as shown in Figure 4. Design and provide sectional detailing of the deep beam using strut and tie method. The characteristic strength of concrete and reinforcement is 35 N/mm^2 and 460 N/mm^2, respectively. Relevant code provisions are given in Appendix A.

(15 Marks)

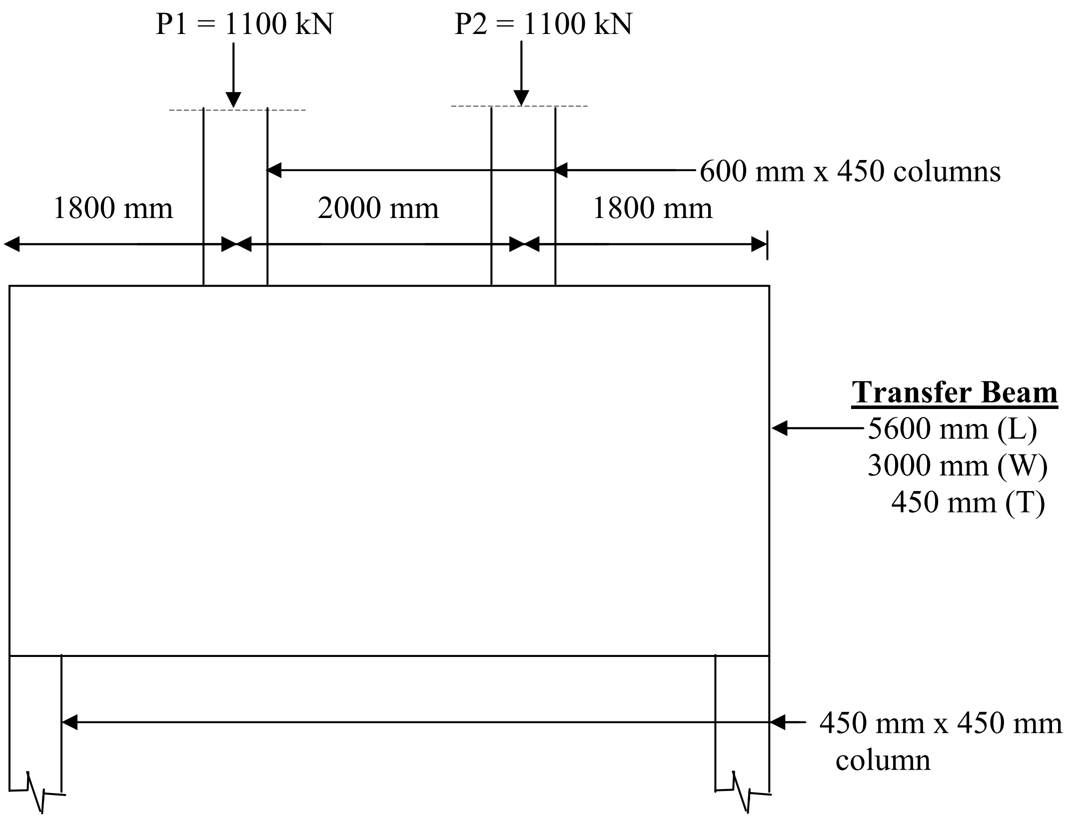

Figure 4 : Deep beam arrangement

6. a) State the rules of yield line theory.

(4 Marks)

b) Figure 5 portrays a rectangular slab that is simply supported along the four edges. If the slab carries a design load for the ultimate limit state is $20kN/m^2$ determine the following using Wood and Armer method.

(i) the design bending moments diagrams for typical strips

(ii) the design load diagrams for the edge beams

(16 Marks)

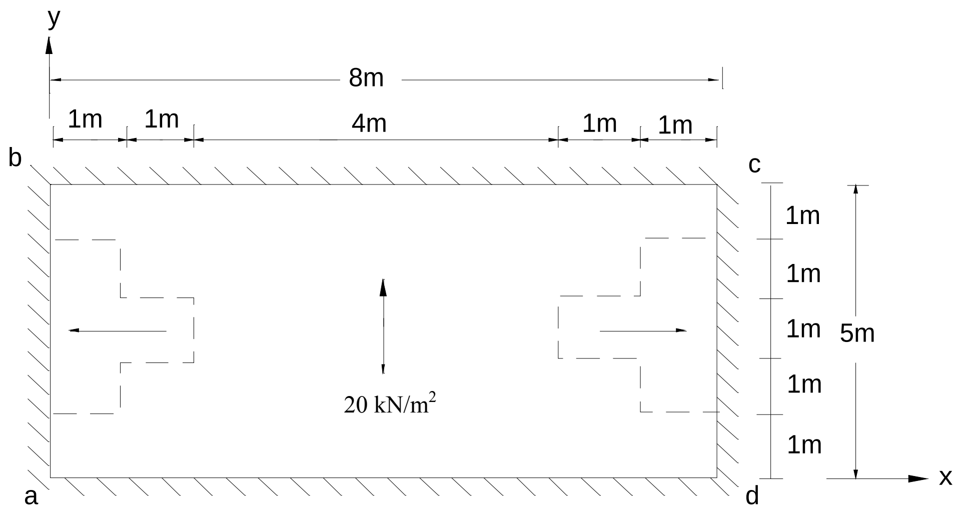

Figure 5

Appendix A

Code Provisions (ACI 318-02)

STRUTS

fcu = 0.85 x ßs x fc’

Where

ßs = 1.0 for prismatic struts in uncracked compression zones

ßs = 0.4 for struts in tension members

ßs = 0.75, struts may be bottle shaped and crack control reinforcement is included

ßs = 0.60, struts may be bottle shaped and crack control reinforcement is not included

ßs = 0.60 for all other cases

fc’ = specified compressive strength of concrete

Note :

1. Crack control reinforcement requirement is Σ ρvi sin γi ≥ 0.003, where ρvi = steel Ratio of the i-th layer of the reinforcement crossing the strut under review, and γi = angle between the axis of the struts and bars.

NODES

fcu = 0.85 x ßn x fc’

Where

ßn = 1.0 when nodes are bounded by struts and/or bearing areas

ßn = 0.8 when nodes anchor only one tie

ßn = 0.60 when nodes anchor more than one tie

STRENGTH REDUCTION FACTOR, Φ

Φ = 0.75 for struts, ties and nodes

- oooOooo -