UNIVERSITI SAINS MALAYSIA

1st. Semester Examination
2005/2006 Academic Session

November 2005

EAS 664/4 – Principle of Structural Design

Duration: 3 hours

Instructions to Candidates:

1. Ensure that this paper contains **SIX (6)** printed pages before you start your examination.
2. This paper contains **FIVE (5)** questions. Answer **ALL (5)** questions.
3. Each question carry equal marks.
4. All questions **CAN BE** answered in English or Bahasa Malaysia or combination of both languages.
5. Each question **MUST BE** answered on a new sheet.
6. Write the answered question numbers on the cover sheet of the answer script.

1. (a) Derive the partial differential equation in X and Y direction for two dimensional stress strain.

(8 marks)

(b) Based on Figure 1, show that the Mohr-Coulumb failure envelope is;

$$\frac{\sigma_1}{f_C'} - \frac{\sigma_3}{f_t^1} = 1 \text{ for } \sigma_1 \geq \sigma_2 \geq \sigma_3$$

where σ_1 : Major principal stress

σ_3 : Minor principal stress

$$f_c^1 = \frac{2\cos\phi}{1-\sin\phi}$$

$$f_t^1 = \frac{2C\cos\phi}{1+\sin\phi}$$

ϕ : Inner friction angle

C : Cohesion force

δ : Shear force

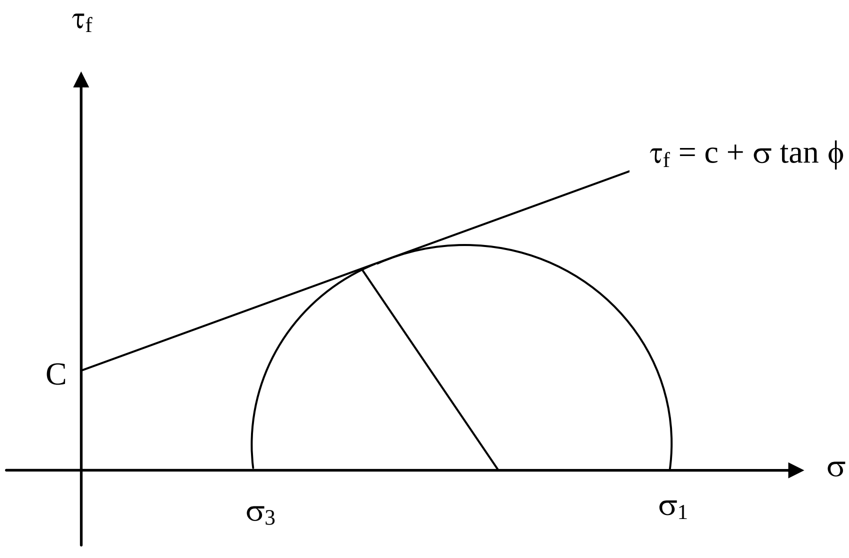

Figure 1

(12 marks)

2. During a tensile test on a 20 mm square bar of a material, a force of 1 ton produced an extension of 0.4 mm in length of 250 mm. The extension reverted to zero on unloading. The force was then reapplied and increased to 1.5 ton, producing a total extension of 1.2 mm.
Determine:

(a) The stress and strain in the bar at 1 ton (elastic condition). (3 marks)

(b) Young's Modulus in elastic condition. (3 marks)

(c) Permanent strain in elasto-plasticity condition. (9 marks)

(d) Sketch the Bauchingger effect for the above testing. (5 marks)

3. (a) Yield line theory has been used for calculating the ultimate strength of a slab bridge. Describe briefly the major drawback of this theory in examining the collapse mechanisms of the slab bridge.

(5 marks)

(b) A solid slab highway bridge has a right span of 10 m and a structural depth of 600mm. The slab bridge has a skew of 25^o and the cross-section is shown in Figure 2.0(a). The specified highway loading is HA and 45 units of HB. The nominal superimposed dead load is equivalent to a uniformly distributed load of $2.5 kN/m^2$, and the nominal parapet loading is 3.5 kN/m along each free edge. Using yield line theory, determine moments of resistance to be provided by bottom reinforcement, placed parallel to the slab edges, for load combination 1. The longitudinal and transverse reinforcement are designed by considering collapse mechanisms (b) and (c), respectively.

(15 marks)

Figure 2.0(a)

Figure 2.0(b)

Figure 2.0(c)

4. (a) Briefly describe and sketch the following **THREE (3)** structural form in order to provide a functional spaces of high-rise building to suit the clients's requirement:
   i) Braced - Frame structures
   ii) Shear – Wall structures
   iii) Braced – Tube structures.

(9 marks)

(b) A ten storey rigid frame building shown in Figure 3 is situated at Johor Bahru in the terrain category 3 with a basic wind speed of 33.5 m/s^2. The basic wind speed has been converted to equivalent horizontal force as shown in Figure 1. The storey height is typically 3.5 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-story level for each 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.

Indicates all values (i – iv) on the diagram.

(9 marks)

(c) Describe the terrain category 3 in MS1553; 2002 and what is the minimum design wind pressure in MS1553;2002?

(2 marks)

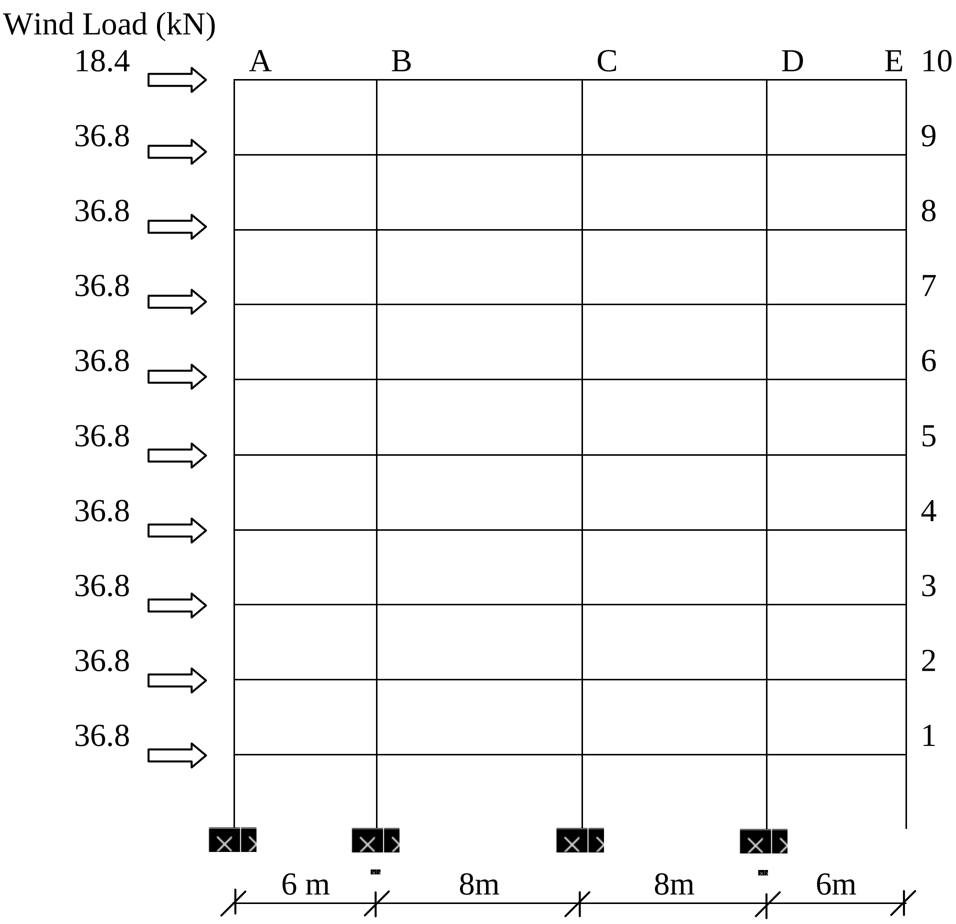

Figure 3

5. (a) Consider the 6000 mm (L) x 500 mm (W) x 2200 mm (H) deep beam described in Figure 4 below. Use the strut and tie model to determine the required amount of reinforcement given:-

f_{cu} = 30 N/mm^2 @ 28 days

f_y = 460 N/mm^2

P1 = P2 = 1400 kN (Ultimate Load)

Bearing Plates = 450 mm x 500 mm

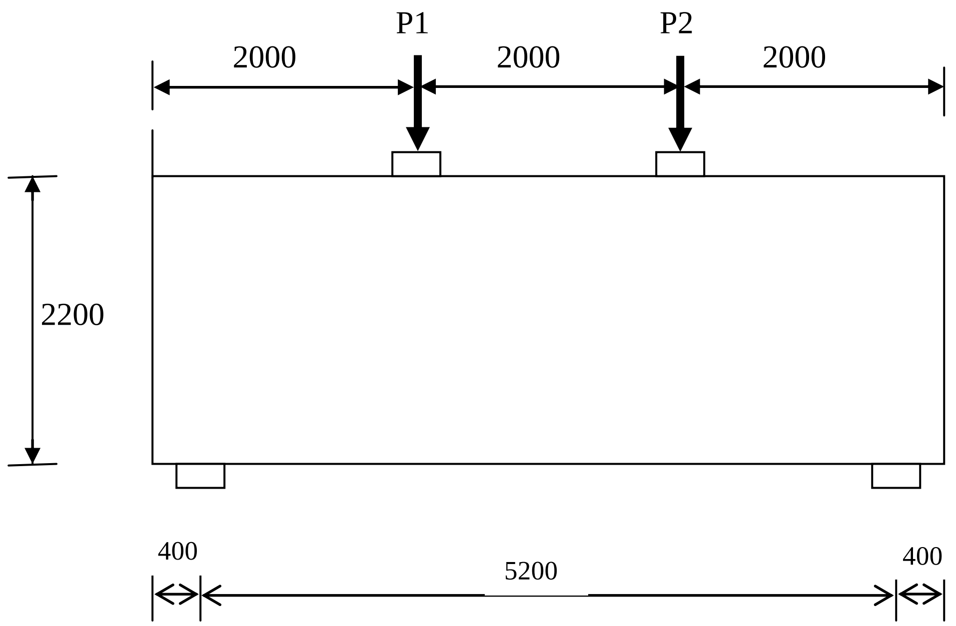

Figure 4 : Deep Beam

(15 marks)

(b) Provide full sketch detailing for the deep beam.

(5 marks)

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