UNIVERSITI SAINS MALAYSIA

1st. Semester Examination
2003/2004 Academic Session

September / October 2003

EAS 353/3 – Design of Reinforced Concrete Structures

Duration : 3 hours

Instructions to candidates:

1. Ensure that this paper contains **SEVEN (7)** printed pages include appendices.
2. This paper contains **SEVEN (7)** questions. Answer **FIVE (5)** questions only. Marks will be given to the **FIRST FIVE (5)** questions put in order on the answer script and **NOT** the **BEST FIVE (5)**.
3. All questions carry the same mark.
4. All questions **MUST BE** answered in Bahasa Malaysia.
5. Write answered question numbers on the cover sheet of the answer script.

1. (a) Sketch suitable diagram showing pressure distribution on footing due following type of soils:

   i. cohesive soil
   ii. sandy soil

(4 marks)

(b) The footing as shown in Figure 1.0 requires to resist characteristic axial and imposed loads of 600 kN and 150 kN, respectively. The column dimension is 300 mm x 300 mm. The safe bearing pressure on the soil is 150 kN/m^2 and the characteristic material strength are f_{cu}=35 N/mm^2 and f_y=460 N/mm^2. Assume the effective depth of footing, d is 420 mm, and the density of concrete for footing is 24 kN/m^3. Given that the critical perimeter = column perimeter + 8 x 1.5d.

Based on Figure 1.0 and the above information, check:

i. the serviceability limit state of the footing
ii. the ultimate limit state of the footing
iii. shear stress at the column face of the footing
iv. punching shear stress of the footing

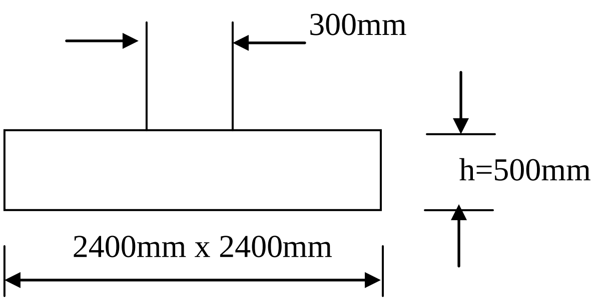

Figure 1.0

(8 marks)

(c) A retaining wall as shown in Figure 2.0 supports soil material of saturated density 2000 kg/m^3. The coefficient of active pressure, K_a is 0.33 and the coefficient of friction, μ is 0.45. Assume the density of concrete is 24 kN/m^3. Based on the given information and Figure 2.0, check the stability of wall against sliding.

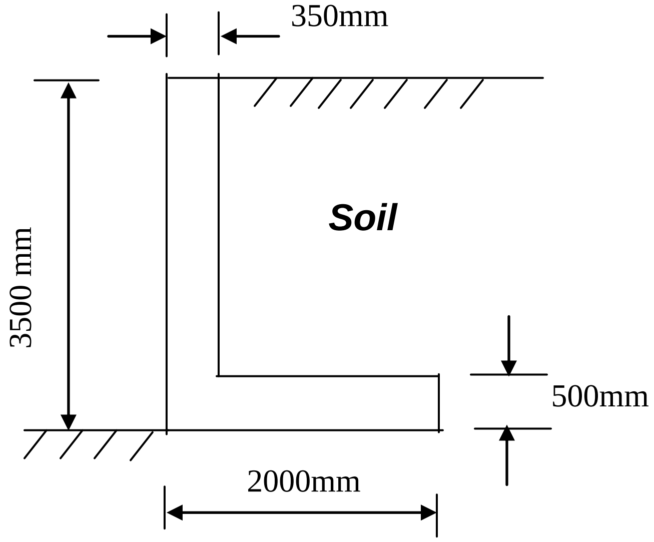

Figure 2.0

(8 marks)

2. (a) Name and sketch **FIVE (5)** types of floor slab normally used in the construction of reinforced concrete slab structures.

(5 marks)

The floor plan for an office building is shown in Figure 3.0. This consists of restrained slabs poured monolithically with the edge beams. The thickness of the slab is 175 mm and the loading is as follows:

Characteristic total dead load = 6 kN/m^2
Characteristic imposed load = 2.5 kN/m^2

Assume the characteristic strength of concrete, f_{cu} = 30 N/mm^2 and characteristic strength of mild steel, f_y = 250 N/mm^2.

i. Determine the location of positive and negative moments and coefficients for slab (2-3/A-B) as shown in Figure 3.0.

(5 marks)

ii. Calculate and sketch the area of reinforcement required at the mid-span and edge strips for slab (2-3/A-B).

(5 marks)

iii. Check the requirements of torsional reinforcement for slab (2-3/A-B) and sketch it at the required location.

(5 marks)

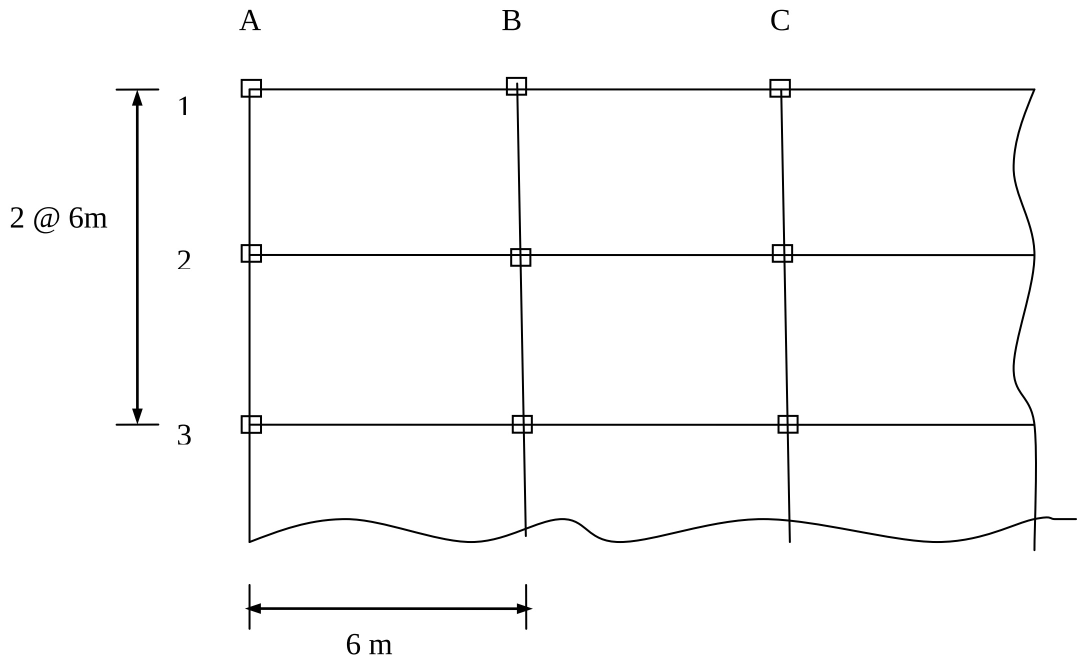

Figure 3.0
Floor Plan For Office Building

3. (a) Figure 4.0(a) shows a frame of a heavily loaded industrial structure for which the centre columns along line RS are to be designed (Column GF-level 1, Column level 1- level 2, Column level 2 - level.3). The frames at 3 m centres, are braced against lateral forces, and support the following floor loads. The characteristic dead load is 10 kN/m^2 and live load is 15 kN/m^2. Assume the characteristic strength of concrete, f_{cu} = 30 N/mm^2 and characteristic strength reinforcement, f_y = 460 N/mm^2. Design the column RS.

(10 marks)

(b) The column section and eccentric loading are shown in Fig. 4.0 (b). Determine the stresses in the concrete and steel to support a concentrated load of 250 kN at 170 mm from the centre line. Assume the characteristic strength of concrete, f_{cu} = 30 N/mm^2 and characteristic strength reinforcement, f_y = 460 N/mm^2.

(10 Marks)

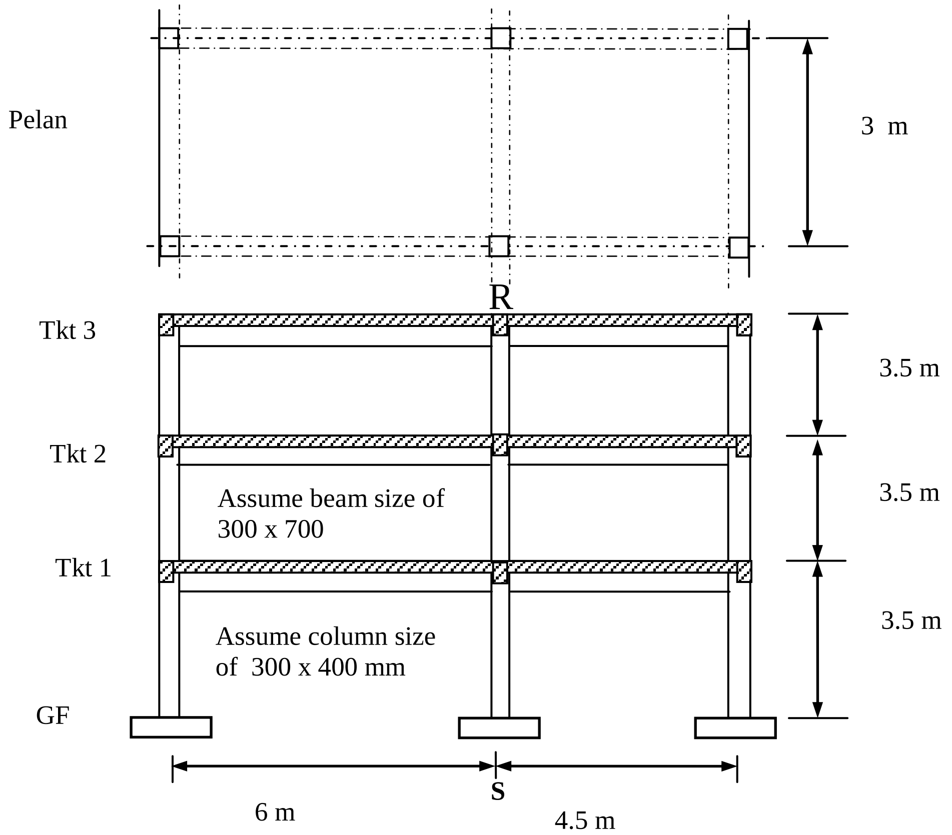

Figure 4.0 (a)
Frame

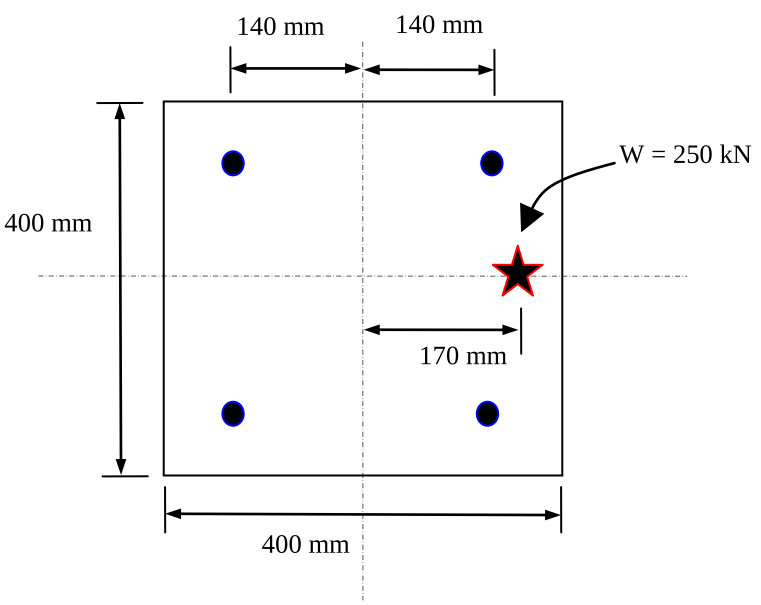

Figure 4.0 (b) Column

4. (a) Show the ultimate moment resistance of a singly reinforced section M_u = 0.156 f_{cu} bd^2 using the stress block where :

f_{cu} = concrete cube strength
b = width of section
d = effective depth of tension reinforcement

(10 marks)

(b) For a singly reinforced section, explain the physical meaning of the following equations.

$$A_s = \frac{M}{0.87 f_y z} (BS 8110, 1985)$$

$$A_s = \frac{M}{0.95 f_y z} (BS 8110, 1997)$$

Where :
M = bending moment
A_s = area of steel
f_y = strength of reinforcement
z = lever arm

(5 marks)

(c) What is the difference between design moment and ultimate moment resistance (Refer to Figure 5.0)

(5 marks)

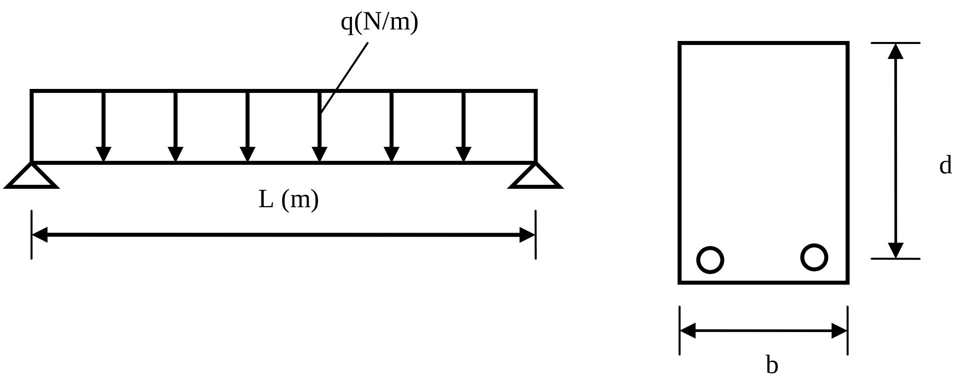

Figure 5.0

5. (a) Using Figure 6.0, design for the shear reinforcement (f_y = 250 MPa) for the beam subjected to imposed load (Qk) and dead load (Gk).

(12 marks)

(b) Produce a 3 dimensional structural drawing sketch based on the result from 5(a).

(3 marks)

(c) Using a diagram, explain the physical meaning for the following equation :

$$a = KL^2 \frac{1}{r_b}$$

where, K = a constant, the value of which depends on the distribution of bending moments in the member

L = the effective span

$\frac{1}{r_b}$ = the mid-span curvature for beams, or the support curvature for cantilevers

a = maximum deflection

(5 marks)

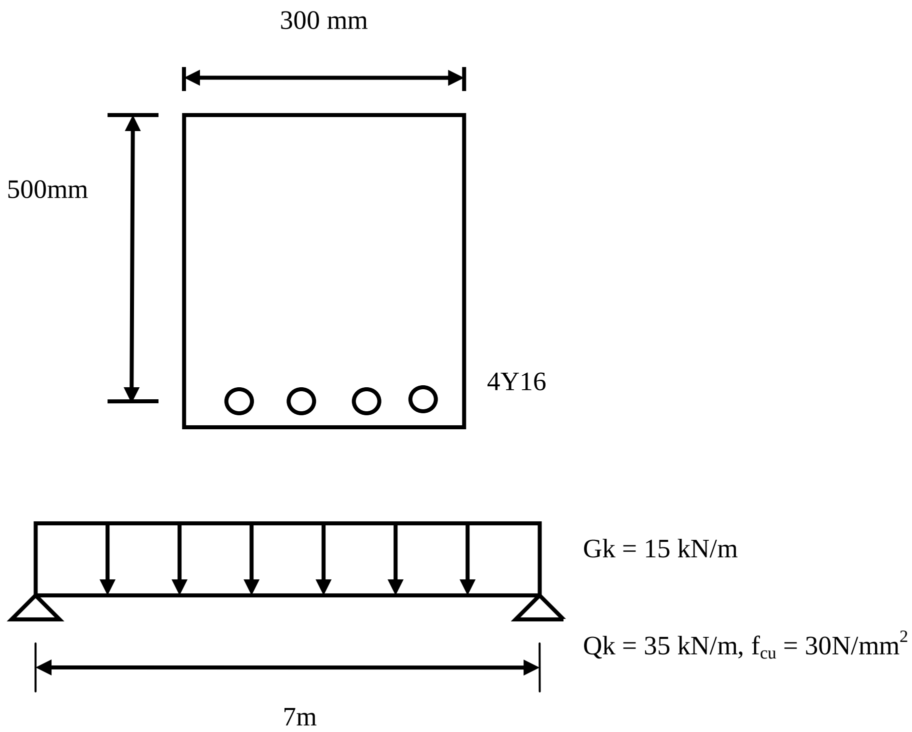

Figure 6.0

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