University of South Australia

2006 End of Year Examination

School	NBE	Subject Area & Catalogue number	CIVE 3003
Course Name		Structural Engineering 2	

Official Reading Time: 10 Minutes
Writing Time: 3 hours

Instructions to Candidates:

- All students must do Question 1. Then choose two more questions from Q 2, 3 and 4. I will only mark three questions for each student.
- Marks for questions are shown in brackets.

Permitted Materials

You may use the following books/information:

- SAA HB2.2 – Australian Standards for civil engineering students Part 2: Structural Engineering 2003 edition (with amendments)
- Smorgon Steel “Your Guide to Steel Reinforcement” photocopy
- A total of 2 double sided A4 pages with any notes, formulae, information etc you desire to include

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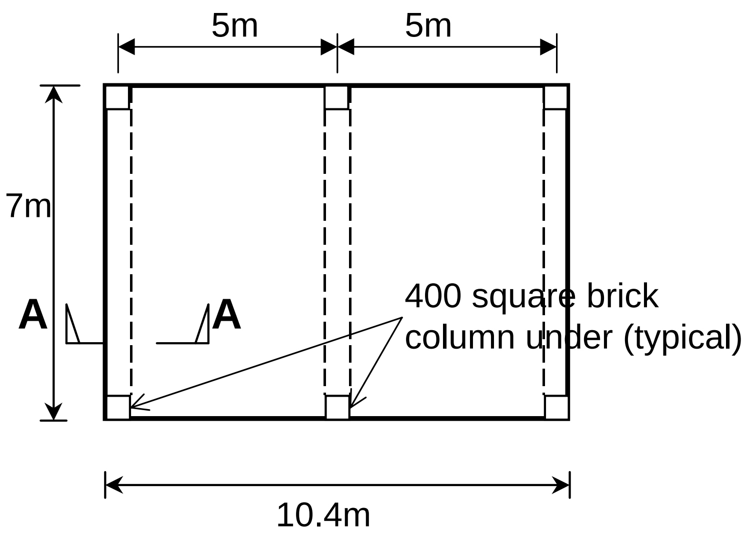
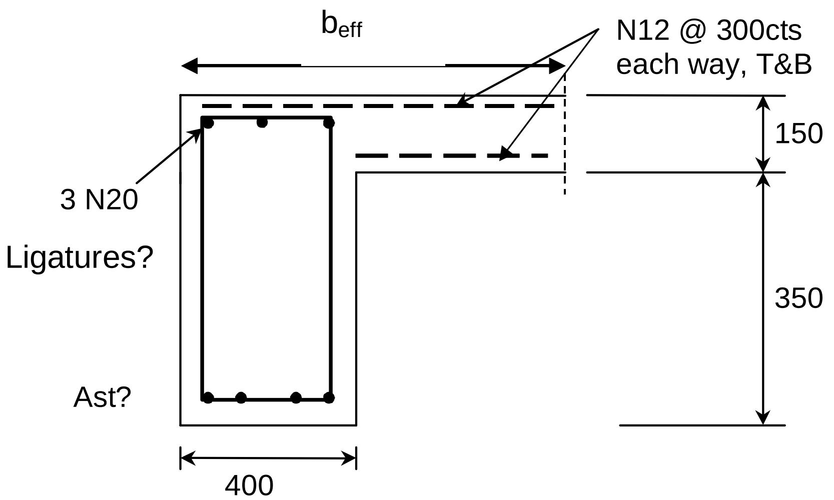
QUESTION 1 – Compulsory, all students must attempt this question

Design the **L-beam** supporting the edge of the floor slab shown below. The building is a shop (retail use). **The slab has already been designed** and is 150 mm thick with N12 bars at 300 mm cts both ways top and bottom. The slab and beams are cast integrally. The beams are simply supported at each end.



FIRST FLOOR PLAN VIEW



SECTION A-A

Exposure classification is B1
f'_c = 32 MPa
f_{sy} = 500 MPa for N bars
$\gamma_{concrete}$ = 24 kN/m^3

Slab loads:

G = self weight + 1 kPa
Q = 4 kPa

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a) Determine the effective flange width, b_{eff}. Determine the number and size of bottom bars (Ast) at mid-span of the beam. You may use a first approximation for Ast but then check using first principles. Show that the beam is ductile. **Ignore steel in the compression zone.**

(22 marks)

b) Determine the size and spacing of the shear ligatures for the beam at the point of maximum shear. Assume the value of Ast calculated in (a) is provided for the full length of the beam.

(8 marks)

c) Using the tensile steel area you calculated in part (a), (or 3N24 if you could not complete part (a)) recalculate the ultimate moment capacity of the beam when the capacity of the compressive steel is included, i.e. design as a double reinforced beam. Neglect the area of slab reinforcement in these calculations. Do no more than 2 trials for the neutral axis depth. Comment on the effect of the compressive steel on the ductility of the beam

(10 marks)

Total marks = 40 marks

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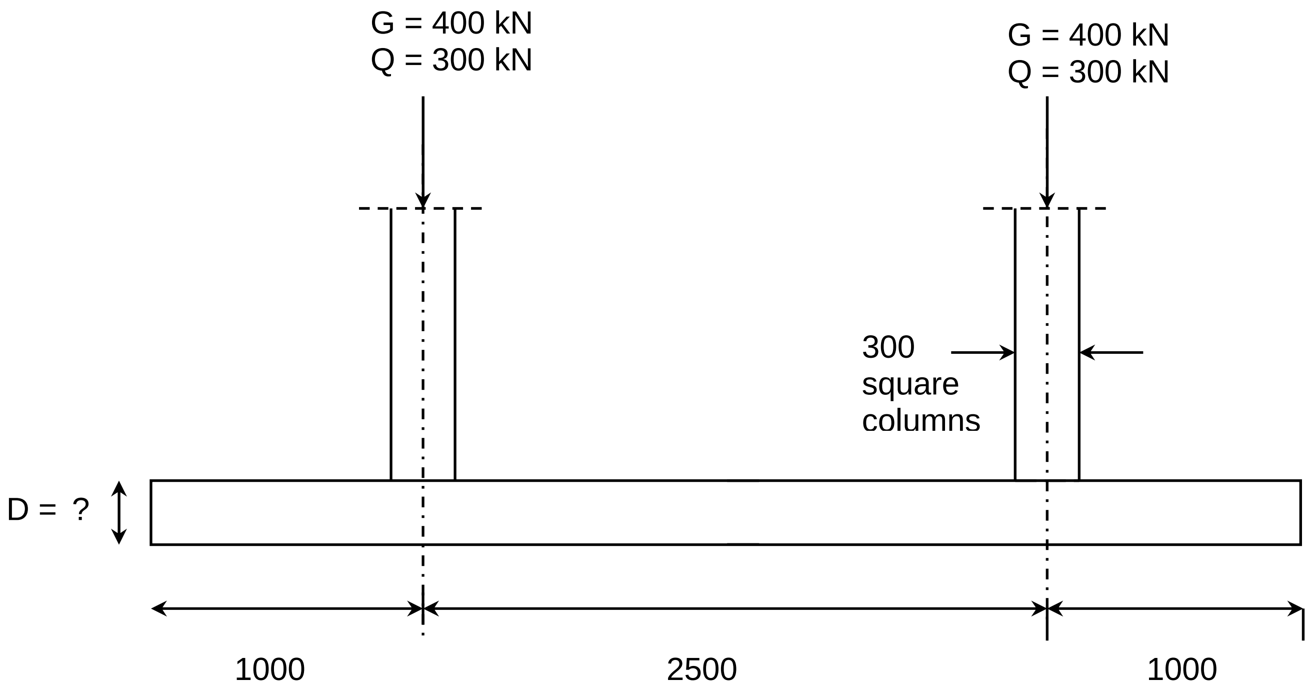
ATTEMPT TWO OF THE FOLLOWING THREE QUESTIONS – YOUR CHOICE – (but I will only mark 2 of them, so don't try all 3 to get more marks)

QUESTION 2

Design a suitable pad footing for the twin columns with geometry and loads as shown:
Assume:

- Uniform bearing pressure over the total area of the footing
- f'_c = 25 Mpa, Exposure category A2, Ψ_s = 0.7, f_{sy} = 500 Mpa
- Ignore any bending moment due to eccentricity, i.e. assume $M^*_v = 0$.



Underground service trenches restrict the length available for the pad footing to 4.5 m, but the width, B, is unrestricted and must be determined.

a) If the footing will be based on a firm clay with an allowable bearing capacity qa = 150 kPa, determine a suitable width B, for the footing. [Hint: For parts (a) and (b) you can treat the footing as two separate halves of equal length and uniform pressure)

(5 marks)

b) For the width determined, find the ultimate bearing pressure qu. Determine the minimum effective depth d, and hence the total depth D, required to satisfy bending shear and punching shear conditions. State any assumptions you make but for this purpose there is no need to recalculate if the assumptions are not correct.

(15 marks)

c) Draw the bending moment diagram for the footing in the long direction (Hint: Think of it upside down with 2 columns as supports). Determine the required flexural reinforcement in the top and bottom of the footing to satisfy bending moment requirements in both directions. Illustrate your reinforcement layout in a sketch (show the side view of the footing as above).

(10 marks)

Total marks = 30 marks

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QUESTION 3

The flat slab shown below has 350 x 350 square columns at 7.5 m centres in each direction. There are drop panels 1.5m x 1.5m square x 150 mm thick at each internal column. There is a perimeter (spandrel) beam 350 mm wide x 700 mm deep.

The slab is in a retail building and supports a live load of 5 kPa and a superimposed dead load of 1 kPa (i.e. in addition to the slab self weight). All internal partitions are of light frame, flexible construction and the slabs will be carpeted (i.e. no tiles).

a) Determine the depth, D of the slab in accordance with the deemed to comply span-to-depth ratio method. [Hint: To estimate self-weight assume D will be at least 240 mm or more. Do not do more than one trial of depth. If you get stuck, take D = 240 mm and continue to part b].

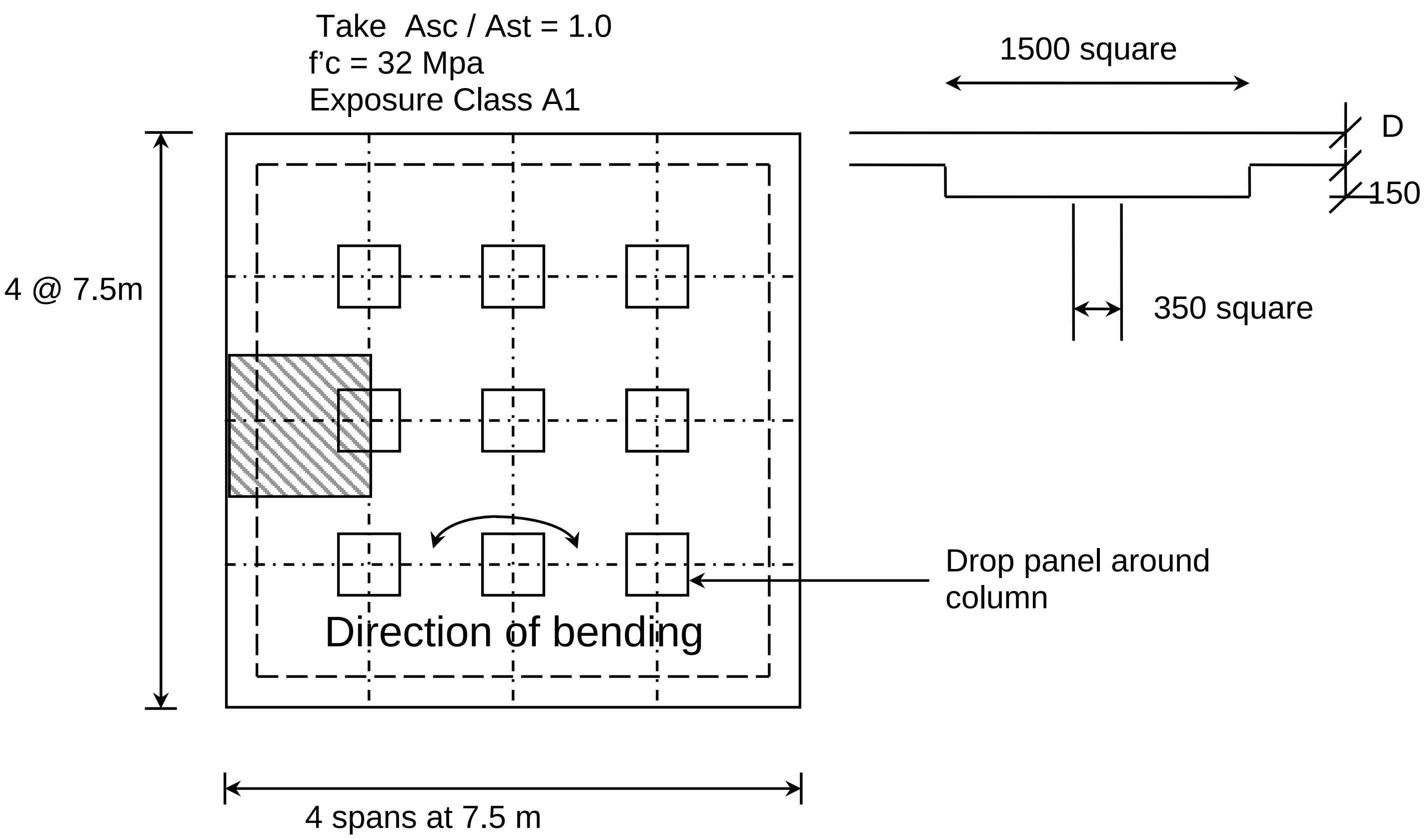
(14 marks)

b) Determine the total static moment M_o in the given bending direction for the shaded area of slab. Distribute the moment to column strips and middle strips in negative and positive moment regions of the shaded area (draw a diagram). Use the Simplified Method of Sec 7.4 and Table 7.5.5.

(16 marks)

Note: You may ignore the self weight of the drop panels.

Total marks = 30 marks



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QUESTION 4

The beam below is simply supported over a span of 8 m. It supports a load width of 4.0 m of floor slab [this is **not** b_{eff}]. The slab spans one way onto the beam and supports a live load of 5 kPa. The floor is tiled with brittle marble tiles which add a superimposed dead load of 1 kPa in addition to the self weight of the concrete beam and slab.

Using the simplified calculation method of Code sec. 8.5.3 calculate:

a) the short term deflection

(24 marks)

b) the **additional** deflection that occurs due to creep and shrinkage after the tiles are laid, and show whether it complies with code limits.

(4 marks)

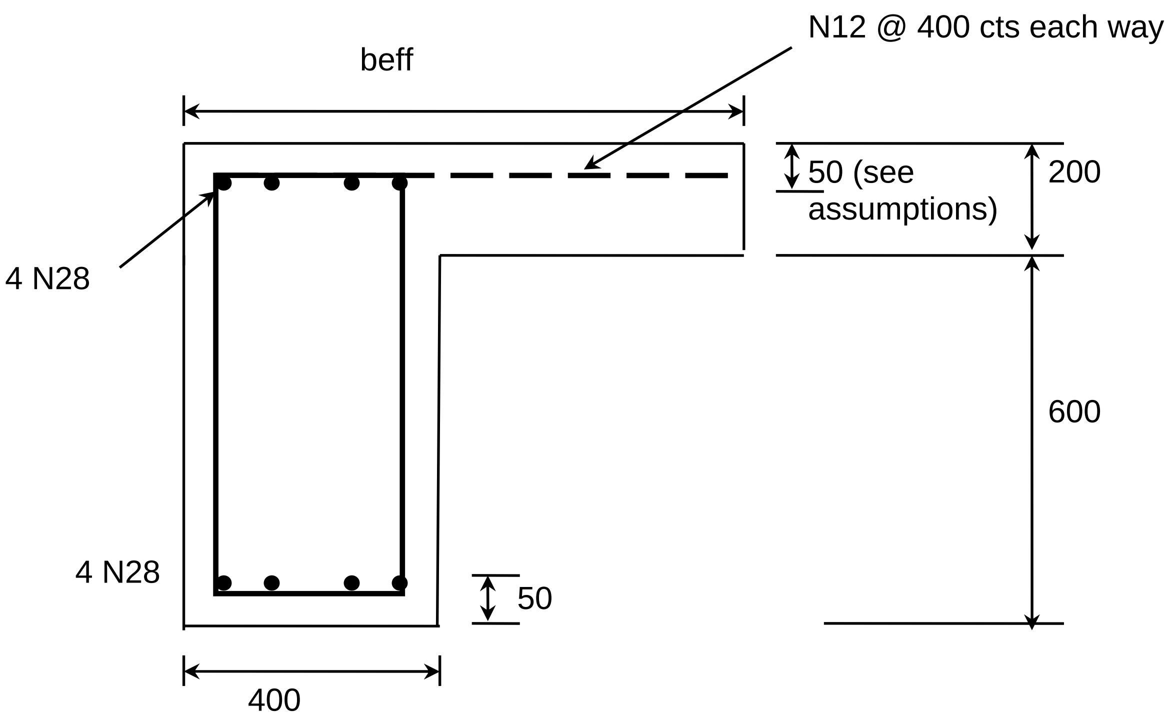
c) the **total** long term deflection, and show whether it complies with code limits.

(2 marks)

Assume:

- f'_c = 32 Mpa
- $\Psi_s = 0.7$ and $\Psi_l = 0.4$
- centre deflection = $\frac{5}{384}\frac{wL^4}{EI}$
- all top steel (slab and beam reinforcement) is centred at 50 mm from the top of the concrete for this exercise
- Interior environment

Total marks = 30 marks



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