UNIVERSITY OF SOUTH AUSTRALIA
SCHOOL OF NATURAL AND BUILT ENVIRONMENTS

SECOND SEMESTER EXAMINATIONS, NOVEMBER 2004

STRUCTURAL ENGINEERING 1

GENERAL INSTRUCTIONS TO CANDIDATES:
Lecturer: J. Mills

Reading Time: 10 mins
Exam Duration: 3 hours

1. **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.
2. Marks for questions are shown in brackets.
3. You may use the following books/information:
   - SAA HB2.2 – Australian Standards for civil engineering students Part 2: Structural Engineering 2003 edition (or 2002 edition with the green paper amendment)
   - Smorgon ARC Reinforcement Pocketbook
   - A total of 2 double sided A4 pages with any notes, formulae, information etc you desire to include

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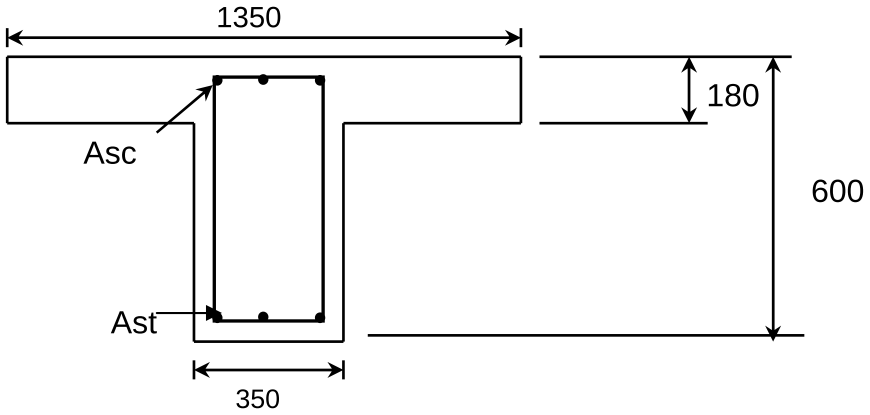
QUESTION 1 – Compulsory, all students must attempt this question

Consider the **simply supported** T-beam shown below.



Beam span = 6 metres
f'c = 32 MPa
Exposure classification = A1
fsy = 500 Mpa

If the dead load, g = 30 kN/m (including self weight) and live load, q = 15 kN/m:

a) Find the maximum design moment, M* at midspan and determine the area of tensile steel required (Ast) **ignoring** the compressive steel (Asc). Express Ast as a number and size of bars. Use first principles of force and moment equilibrium for your calculations, and show that the beam is ductile.

[14 marks]

b) Find the maximum design shear, V* and determine the shear reinforcement required (size and spacing of ligatures).

[12 marks]

c) If the live load is increased to q = 60 kN/m, determine the design shear force V* and the shear reinforcement required. Use your previously calculated values of V_{uc} and **do not** assume cot θ_v = 1.

[7 marks]

d) If the area of steel is specified as 3 N32 bars, top and bottom, does the section have adequate moment capacity for the design M* when q = 60 kN/m? Use strain and force diagrams to explain your answer. (Hint: Take the first trial for neutral axis position through the compressive steel.) Do no more than 2 trials.

[7 marks]

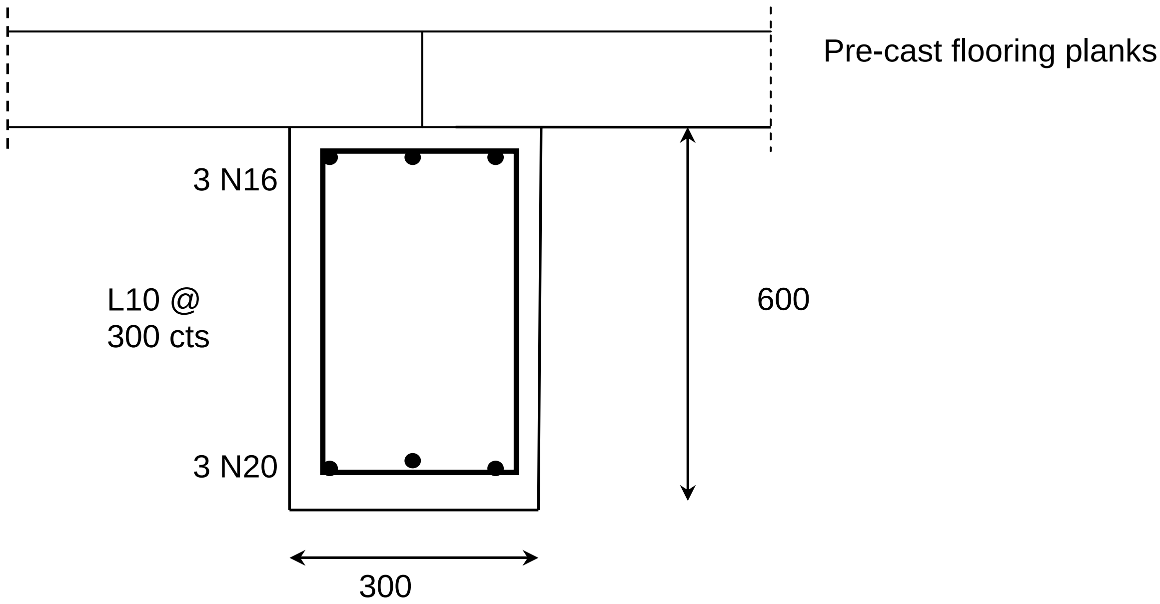
Total = 40 marks

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

The beam below is simply supported over a span of 4.5 m. It supports precast floor panels that span one-way onto the beam, with an effective load width of 8m. The permanent load of the floor panels is 4 kPa, with a topping slab and tiled finish adding a further 2 kPa permanent load. The imposed load is 3 kPa.

Assume:
- f'_c = 32 Mpa
- $\Psi_s = 0.7$ and $\Psi_l = 0.4$
- centre deflection = $\frac{5}{384}\frac{wL^4}{EI}$
- cover = 40mm all round
- Exterior environment, temperate inland



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

a) the short term deflection

[22 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. How could this deflection be reduced without increasing the beam size?

[4 marks]

Total = 30 marks

QUESTION 3

Determine suitable dimensions and reinforcement for the square pad footing supporting an isolated column with geometry and loads as shown below. State any assumptions you make in your analysis and verify that they are reasonable.

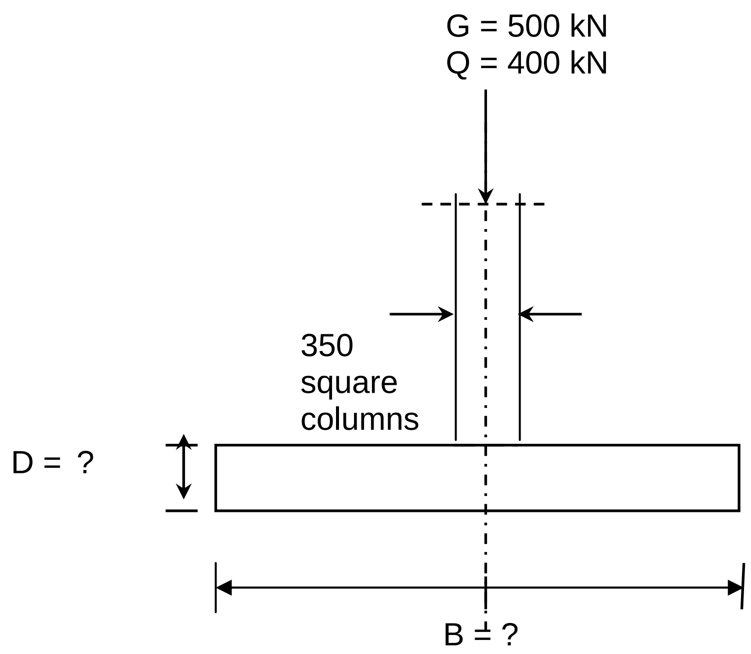
a) Assume:

- Uniform bearing pressure over the total area of the footing.
- Allowable bearing pressure, q = 150 kPa.
- 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 $M^*_v = 0$.

[15 marks]

b) If there is a moment of 100 kNm (unfactored) due to live load eccentricity, redesign the footing as necessary to accommodate this design moment.

[15 marks]



Total = 30 marks

QUESTION 4

The flat slab shown below has 300 x 300 square columns at 7.0 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 300 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 220 mm or more. Do not do more than one trial of depth. If you get stuck, take D = 220 mm and continue to part b].

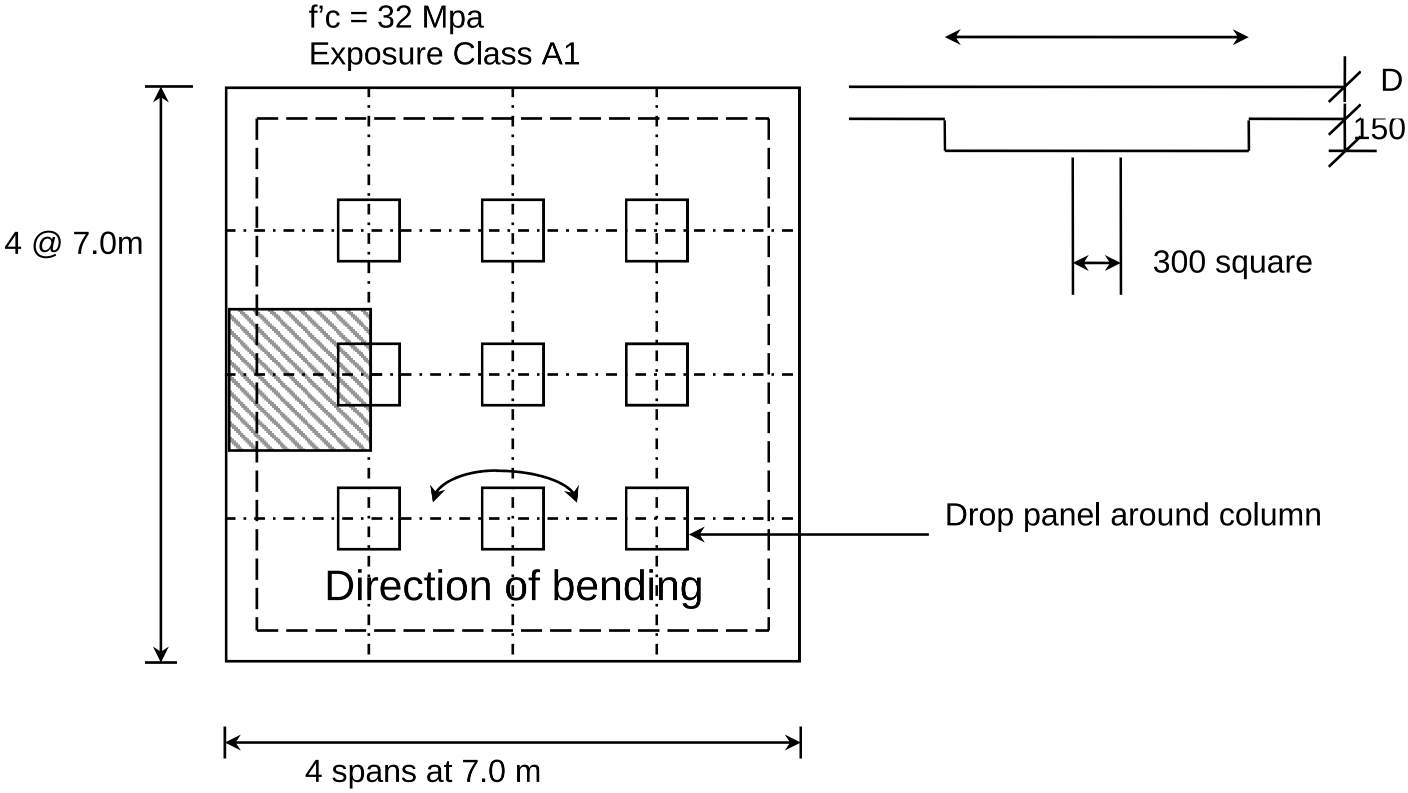
[14 marks]

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 panel for part b).

Take Asc / Ast = 1.0
f'c = 32 Mpa
Exposure Class A1



Total = 30 marks