

Assignment #3

2 problems, total = 60 marks

Problem 1 (30 marks)

The beam in **Figure 1** spans 6 m and is simply supported on walls which have a thickness of 240 mm. The beam is subjected to a uniform service (unfactored) dead load $w_D = 10$ kN/m (which includes self-weight) and uniform service live load $w_L = 16$ kN/m:

- If the beam width (b) is fixed at 250 mm, propose a beam height (h) taking into account deflection requirements, while also trying to ensure that the final beam design will result in a beam which is moderately reinforced (i.e. $\rho \leq 75\% \rho_{bal}$)
- The senior engineer insists on using $h = 450$ mm. Using these dimensions (250 mm x 450 mm), design the beam such that $M_r \geq M_f$ (under 1.25D+1.5L), while ensuring the max and minimum reinforcement requirements of the code are met.
 - Note: when selecting the area of steel use the iterative method, and then verify that $M_r \geq M_f$ using the actual A_s used in design.
- Verify that your beam design meets the various requirements in the CSA A23.3 standard (bar spacing and z-factor) and show a final design summary.

- * use: $f_c = 35$ MPa, $f_y = 400$ MPa
- * use: 25M bars, 10M stirrups and a 30 mm clear cover
- * max . aggregate size (a_{max}) = 20 mm
- * the beam can be considered to have normal exposure conditions

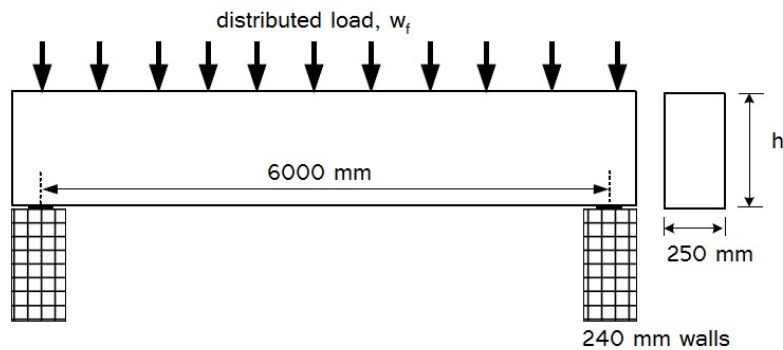


Figure 1

Problem 2 (30 marks)

The fixed end beam (both ends fixed) in **Figure 2** spans $L=7.5$ m and is located in a parking structure (exposure to freeze/thaw and chlorides, exposed conditions: requires cover of 60 mm !).

To fit with the other architecture in the structure, the beam must be 500 mm wide (b) and **800 mm in height (h)**. The concrete is to be $f'_c = 40\text{MPa}$. The stirrups are **10M**.

The uniform loading is as follows: Service dead load = 60 KN/m (includes self-weight), Service live load = 35 KN/m .

- a. Using **30M bars**, design the critical beam section in negative bending such that the CSA A23.3 requirements for strength ($M_r \geq M_f$ for $1.25D + 1.5L$), cover, bar spacing and crack control (z-factor) are met. If it does not work try and use **25M** bars instead !

- **Note:** use the CDH tables to determine A_s and to verify M_r

- b. Using **20M bars**, repeat for the critical beam section in positive bending

- **Note:** use the CDH tables to determine A_s and to verify M_r

- c. Is skin reinforcement required ? If yes, design this reinforcement (use 10M bars)
- d. Provide a design summary sketch for the beam (sketch approximately how the reinforcement would be placed along the beam length and also show the critical beam cross-section details; however, do not calculate bar cutoffs)

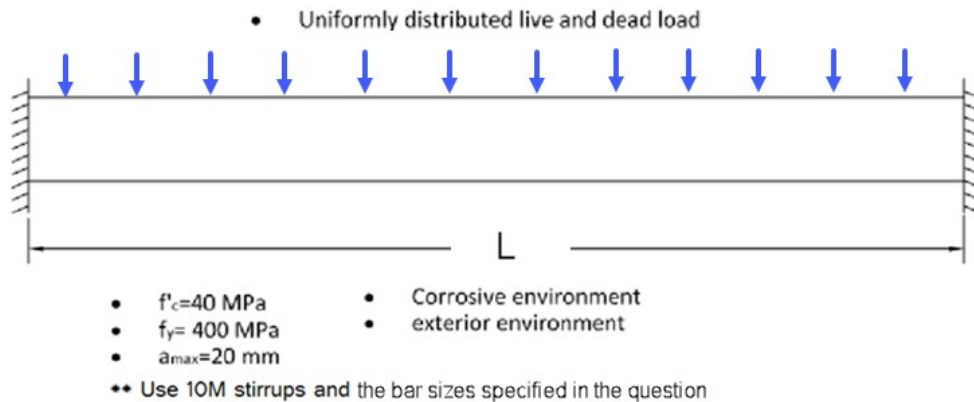


Figure 2

Note: use the following figure to determine moments; the section for question "a" is at the ends, the section for question "b" is in the middle !

