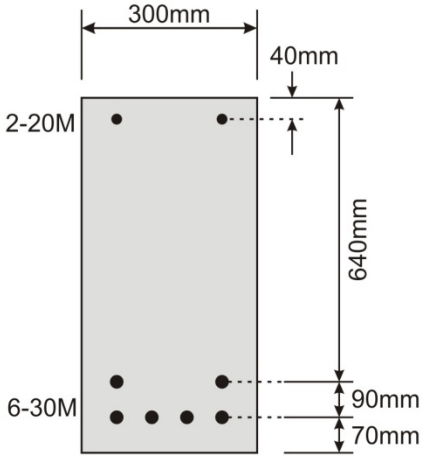
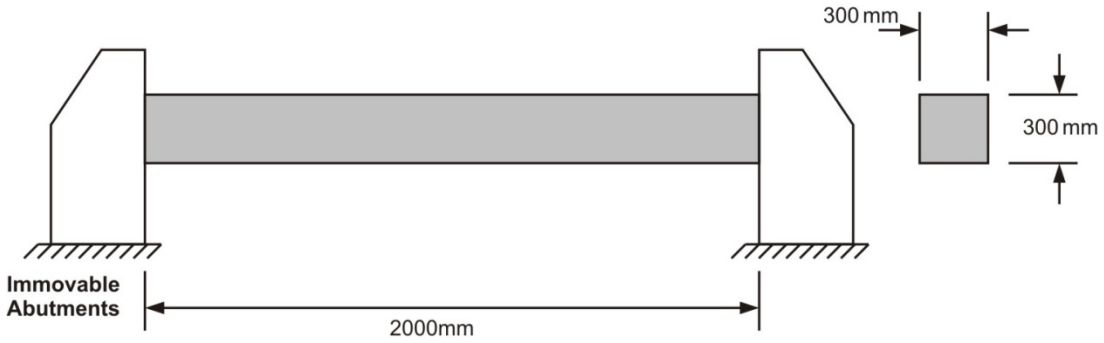
Question 1:

a) Calculate the factored moment resistance, $\mathbf{M_R}$, of the section shown at right.
b) What is the largest area of tension steel, $\mathbf{A_s}$, that could be used while still having an under-reinforced beam?



Question 2:

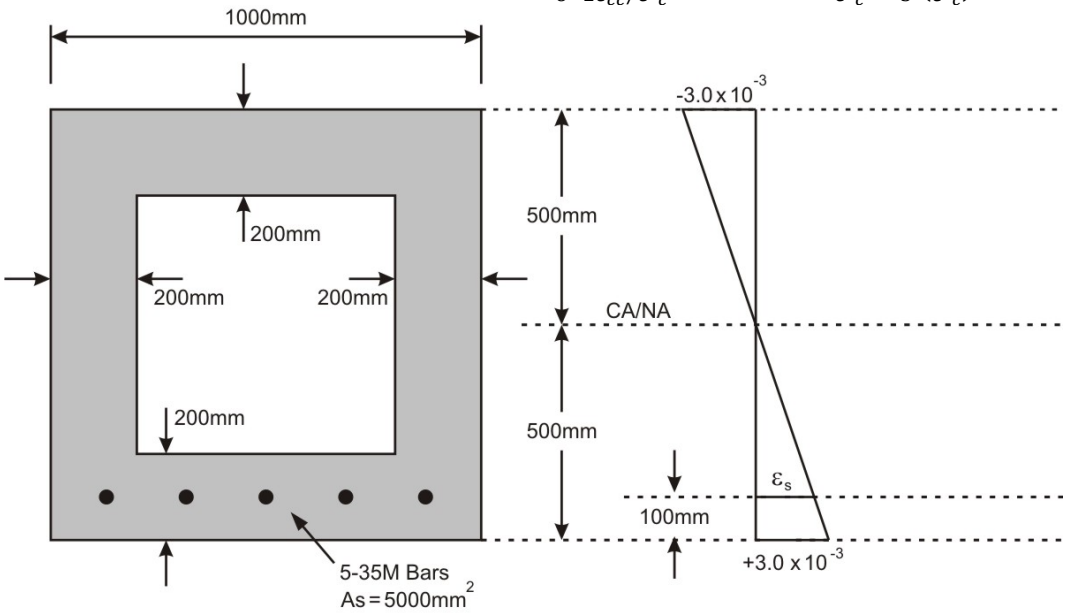
The concrete element below is fixed between two immovable abutments. What force, **N**, will the abutments apply to the element if the temperature quickly increases by 50°C? If the concrete is in tension, use E_c=30,000MPa. If it is in compression, use the Hognestad parabola, where $f_c = -f'_c\left(2(\epsilon_{cf}/\epsilon'_c) - (\epsilon_{cf}/\epsilon'_c)^2\right)$. Ignore creep and shrinkage.



Question 3:

Strain gauges affixed to the top and bottom of the hollow-box reinforced concrete beam shown below indicate that the strains in the concrete are as shown. Calculate the applied axial load, **N**, and applied moment, **M** on the section.

Use stress block factors α_1 and β_1 where $\beta_1 = \frac{4-\epsilon_{cc}/\epsilon'_c}{6-2\epsilon_{cc}/\epsilon'_c}$ and $\alpha_1\beta_1 = \frac{\epsilon_{cc}}{\epsilon'_c} - \frac{1}{3}\left(\frac{\epsilon_{cc}}{\epsilon'_c}\right)^2$.



For all questions the material properties are f'_c=30MPa, ε'_c=-0.002, f_y=400MPa, E_s=200,000MPa, $\alpha_c = \alpha_s = 12\text{x}10^{-6}/^oC$ and ignore self-weight.