

Tutorial 1 – Reinforced Concrete 1

Chapter 2 – Exercises

Exercise 1

A frame (beam on two columns) carries a uniformly distributed live load $Q = 5 \text{ kN/m}$ on a beam of span $L = 3.5 \text{ m}$ (Figure 1).

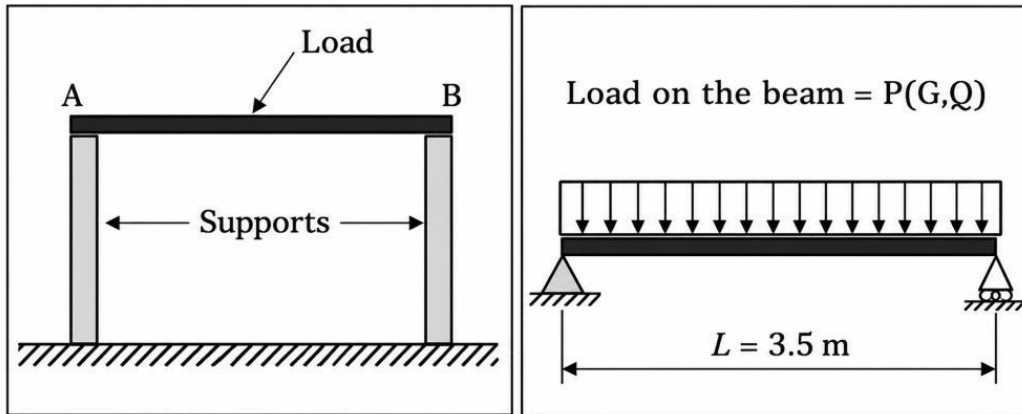


Figure 1 – Frame and beam model

1. Determine the support reactions R_A and R_B .
2. Find the maximum bending moment in the beam (critical section).
3. Compute M_u and M_{ser} of the beam and the axial forces N_u and N_{ser} of the columns (ULS and SLS combinations).

Given: beam section $b \times h = 45 \times 60 \text{ cm}$; concrete unit weight $\rho = 25 \text{ kN/m}^3$.

Exercise 2

A cantilever AB ($L = 1.75 \text{ m}$, fixed at A) carries a uniform self-weight G , a uniform live load Q , and a permanent point load F at its free end B (Figure 2).

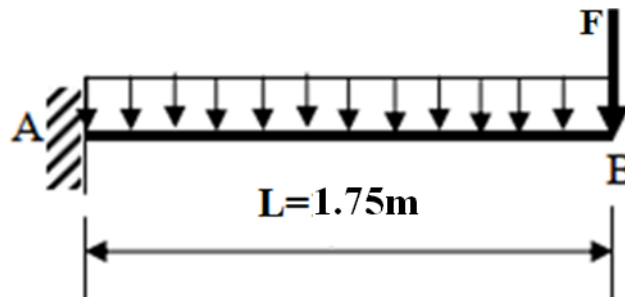


Figure 2 – Cantilever beam

1. Determine the most unfavourable bending moment M_A and shear force T_A .
2. Deduce the critical section at the ULS and SLS.

Given: $G = 2000 \text{ daN/m}$; $Q = 3500 \text{ daN/m}$; $F = 10 \text{ kN}$.

Exercise 3

A rectangular RC beam ($b \times h = 300 \times 500$ mm, $d = 450$ mm) is under simple positive bending (top fibre compressed).

1. Write the geometric relationship between ϵ_b , ϵ_s and y_u
2. Find the neutral axis position y_u for which concrete and steel reach their limit strains simultaneously.
3. Identify the failure mode if y_u is smaller than this value.

Given: $f_{c28} = 35$ MPa ; Fe500 ; $\epsilon_{cu} = 3.5 \text{ ‰}$; $\epsilon_{su} = 10 \text{ ‰}$; $z \approx 0.9 d$.

Exercise 4

A rectangular RC beam under positive bending is designed with the simplified rectangular stress block.

1. Calculate the concrete design stress f_{cu} .
2. Find the neutral axis position y from the equilibrium of forces.
3. Identify the pivot (A, B) from the concrete and steel strains.

Given: $b = 300$ mm ; $h = 550$ mm ; $d = 500$ mm ; $f_{c28} = 30$ MPa ($\gamma_c = 1.5$) ; $f_e = 500$ MPa ($\gamma_s = 1.15$) ; $A_s = 1800 \text{ mm}^2$.
