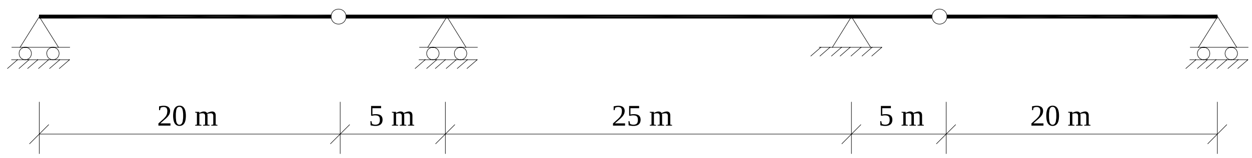
CONCORDIA UNIVERSITY

Department of Building, Civil and Environmental Engineering

BCEE 345 - STRUCTURAL DESIGN II (Reinforced Concrete Design)

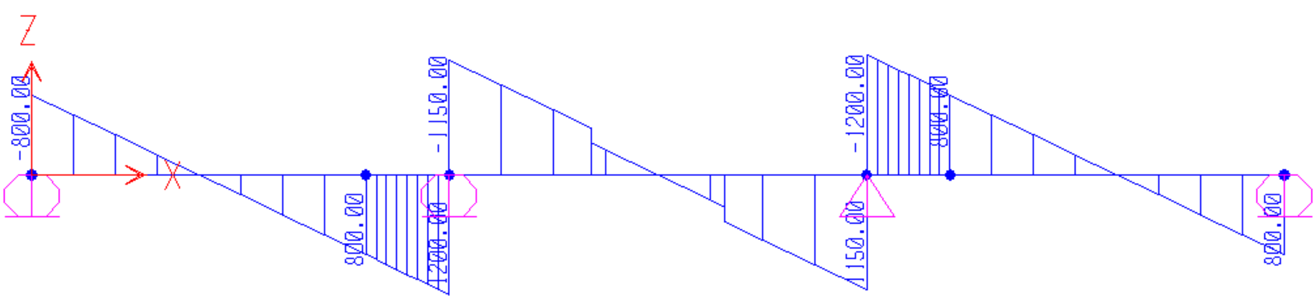
ASSIGNMENT 1 SOLUTION

Question 1(a)

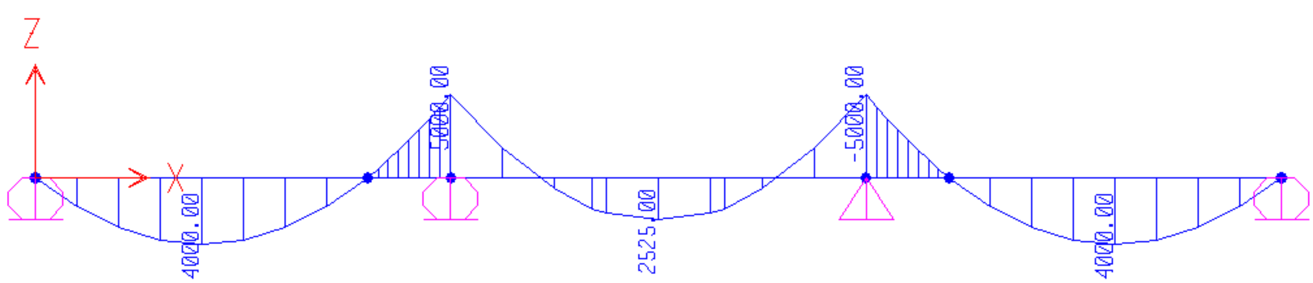


Statical System

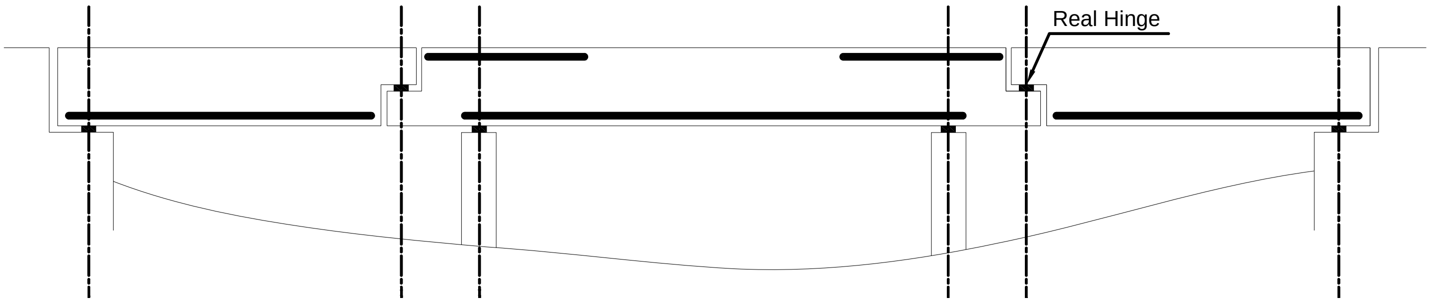
Reactions



Shear Force Diagram



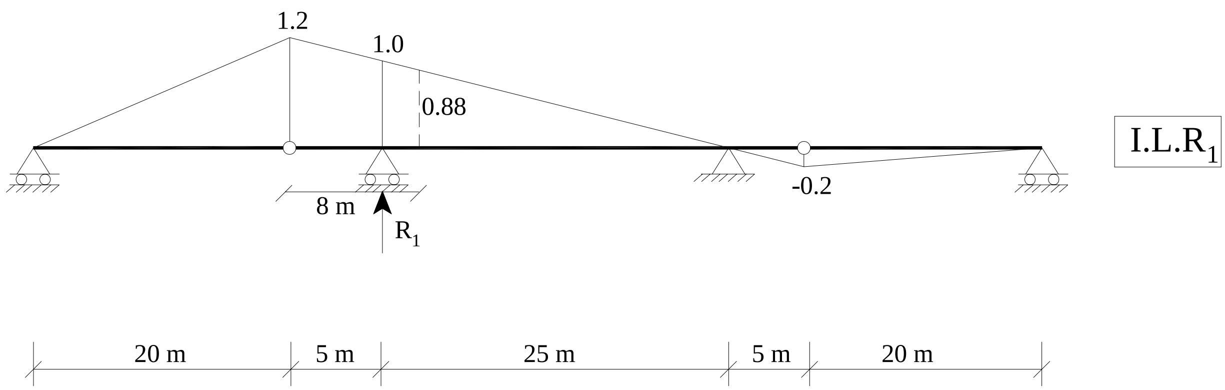
Bending Moment Diagram

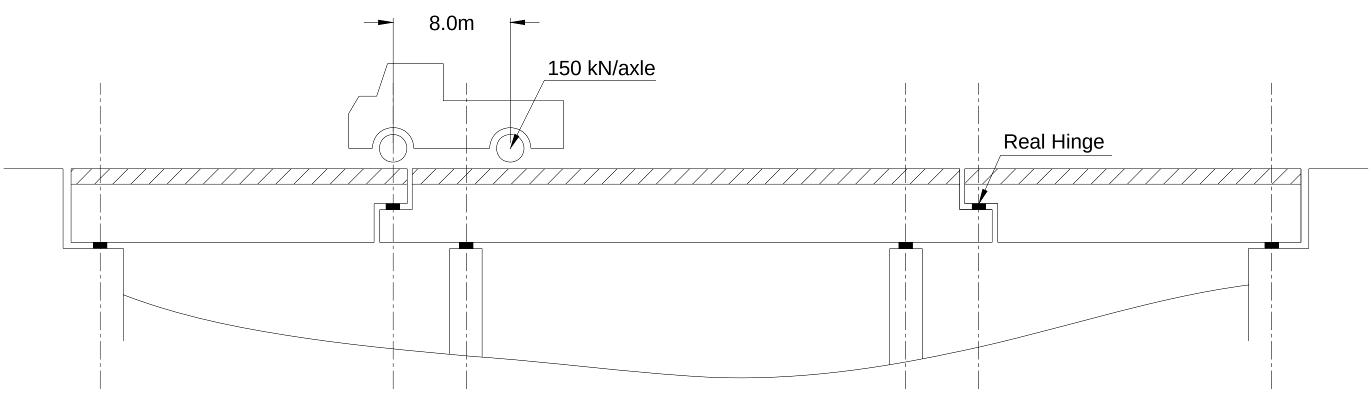


Reinforcement layout

Question 1(b)

To find the maximum reaction R_1 due to the truck load, we need to draw the Influence line for the reaction R_1.



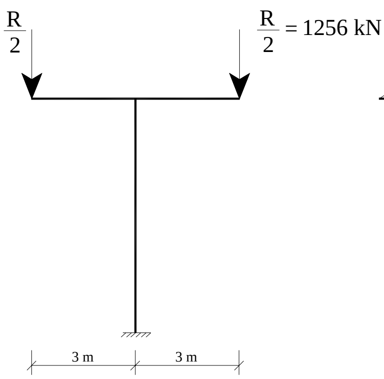


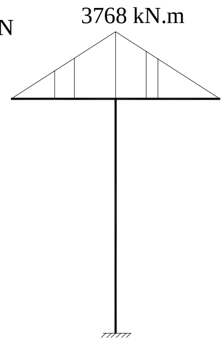
Case of Maximum Reaction

By solving this case, the Maximum reaction due to the truck only would be 1.2 x 150 + 0.88 x 150 = 312 kN

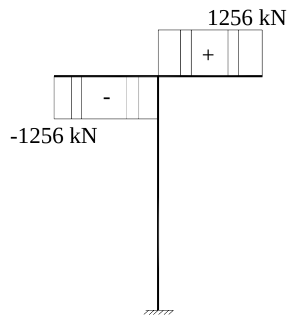
The reaction due to the girder self weight = w x (sum of I.L area) = 80 [0.5 x 50 x 1.2 – 0.5 x 25 x 0.2] = 2200 kN

Therefore, the total reaction (R) = 2200 + 312 = 2512 kN

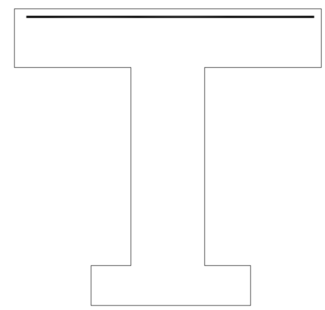




Bending Moment Diagram



Shear Force Diagram



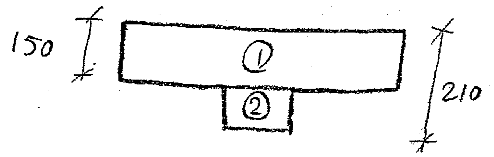
Main Reinforcement

Question (2)

a) Sec 1

Compression force ; $C_1 = 210 \times 250 \times 25 = 1312500$ N

Sec 2



first rectangular part : $P_1 = 150 \times 750 \times 25 = 2812500$ N

Second " " : $P_2 = (210-150) \times 250 \times 25 = 375000$ N

$\rightarrow C_2 = P_1 + P_2 = 2812500 + 375000 = 3187500$ N

b) tension stress in bars:

Due to equilibrium : Compression in Concrete = tension in steel

$C = T$; $A_s = 4 \times 700 = 2800$ mm^2

Sec 1

$T_1 = C_1 = 1312.5$ KN

$(F_s)_1 = \dfrac{T_1}{A_s} = \dfrac{1312.5 \times 10^3}{2800} = 468.75$ MPa

Sec 2

$T_2 = C_2 = 3187.5$ KN

$(F_s)_2 = \dfrac{T_2}{A_s} = \dfrac{3187.5}{2800} = 1138.39 < \underline{\underline{f_y}}$ special steel

c) Bending moment acting on the section.

Taking moment about tension steel

Sec 1 : $M_1 = C_1 \times (550 - 50 - 210/2) = 518.438$ KN.m

Sec 2 : $M_2 = P_1 (550 - 50 - 150/2) + P_2 (550 - 50 - 150 - (210-150)/2)$

$= 1195.31 + 120 = 1315.31$ KN.m

Question (3):

The Combinations of the code are:

Comb 1 = 1.4 D

Comb 2 = 1.25 D + 1.5 L

Comb 3 = 1.25 D + 1.5 L + 0.4 W

Comb 4 = 1.25 D + 1.5 L − 0.4 W

Comb 5 = 1.25 D + 1.4 W

Comb 6 = 1.25 D − 1.4 W

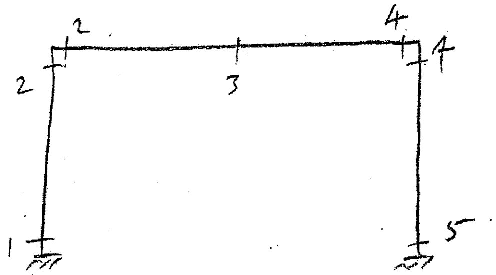
Comb 7 = 1.25 D + 1.4 W + 0.5 L

Comb 8 = 1.25 D − 1.4 W + 0.5 L

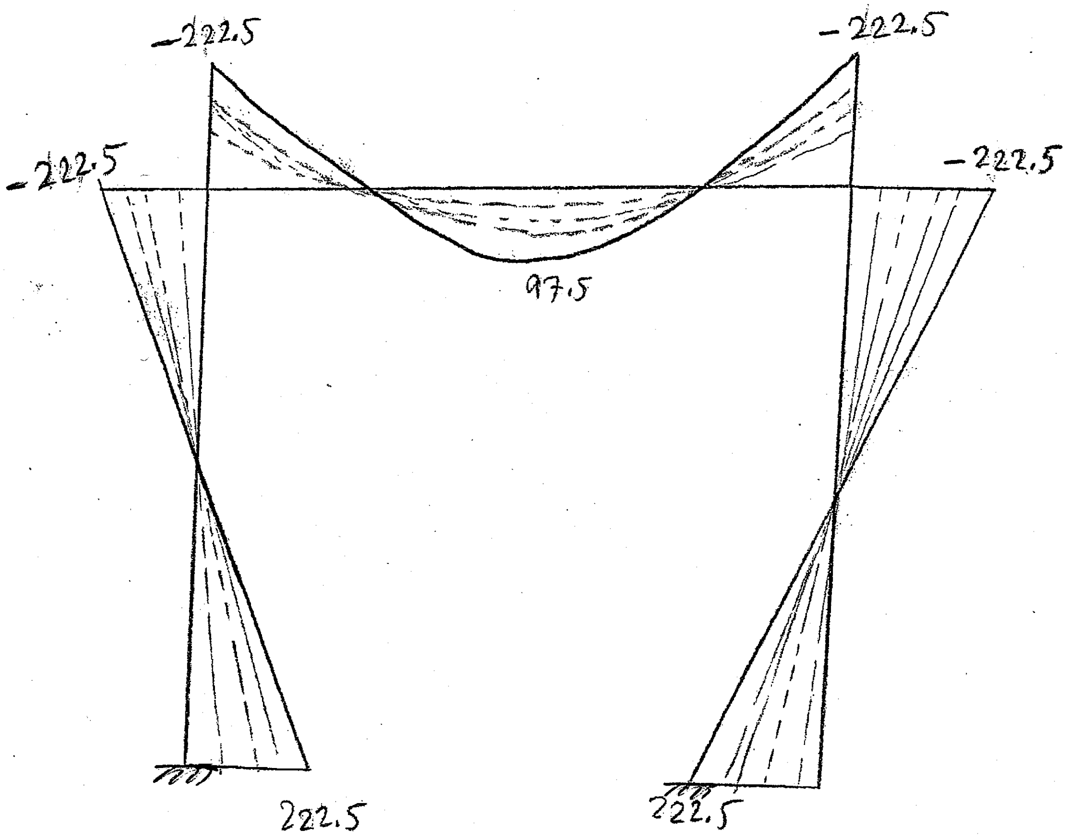
Generally we need to consider combos with 0.9 coeficient for Dead load but in this example it will always give the smaller number so no need to involve that.

we have here 5 sections

Section	D	L	W
1	60	85	−50
2	−60	−85	50
3	30	40	0
4	−60	−85	−50
5	60	85	−50



Sec	Comb1	Comb2	Comb3	Comb4	Comb5	Comb6	Comb7	Comb8
1	84	202.5	182.5	222.5	5	145	47.5	187.5
2	−84	−202.5	−182.5	−222.5	−5	−145	−47.5	−187.5
3	42	97.5	97.5	97.5	37.5	37.5	57.5	57.5
4	−84	−202.5	−182.5	−222.5	−145	−5	−187.5	−47.5
5	84	202.5	182.5	222.5	145	5	187.5	47.5



Max - Max BMD.

Question (4)

Variation in temperature ; ΔT

$\varepsilon = \alpha \Delta T$

Tensile Stress: $f_t = \varepsilon \times E_c = \alpha \Delta T E_c$

Allowable tensile stress for a member under pure tension is:

$f_r = 0.33 \lambda \sqrt{f'_c} = 0.33 \times 1 \times \sqrt{25} = 1.65$ MPa

crack in beam : $f_t = f_r$

$$\alpha \Delta T E_c = f_r \rightarrow \Delta T = \frac{f_r}{\alpha E_c} = \frac{1.65}{(10 \times 10^{-6})(4500\sqrt{25})} = 7.33$$

temperature that causes crack : $20 - 7.33 = \boxed{12.67\,^{\circ}C}$