REINFORCED CONCRETE DESIGN 1

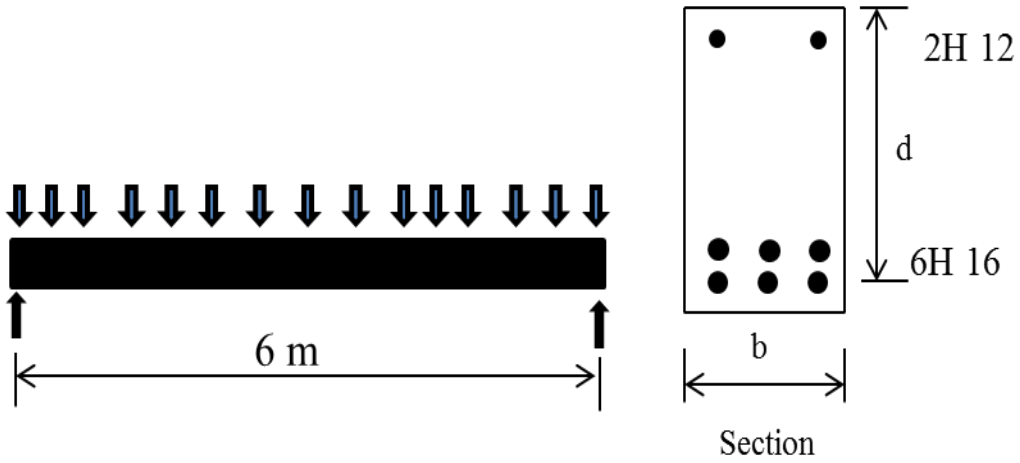
Deflection, Cracking and Detailing (Example and Tutorial)

by
Dr. Sharifah Maszura Syed Mohsin
Faculty of Civil Engineering and Earth Resources
maszura@ump.edu.my

Example: Deflection

A simply supported rectangular beam spanning 6 m is 200 mm width and 450 mm effective depth. The area of tension steel required is 1200 mm^2 and the area compression steel required is 200 mm^2. Bars 6H20 and 2H12 are provided for tension and compression reinforcement steel respectively. Verify for deflection consideration according EC2. Use concrete strength f_{ck} = 25 N/mm^2 and f_{yk} = 500 N/mm^2 for steel strength.

Example: Deflection



Span = 6.0 m

Size, *b x d* = 200 x 450 mm

Design Load, w = 100 kN/m

Compr. steel : As_{req} = 1200 mm^2 A_{sprov} = 1207 mm^2

Tension steel : As'_{req} = 200 mm^2 $A_{s'prov}$ = 226 mm^2

Charc. Strength of concrete, f_{ck} = 25 N/mm^2

Charc. Strength of steel, f_{yk} = 500 N/mm^2

Example: Deflection

Percentage of required tension reinforcement

ρ $= As_{req} / bd = 1200 / (200 \times 450)$

$= 0.013$

Reference reinforcement ratio.

$\rho_o = (f_{ck})^{1/2} \times 10^{-3} = (25)^{1/2} \times 10^{-3}$

$= 0.005$

Percentage of required compression reinforcement,

ρ' $= As'_{req} / bd = 200/(200 \times 450)$

$= 0.0022$

Factor for structural system , K = 1.0

$\rho_o = 0.005 < \rho = 0.013$

Example: Deflection

$$\frac{l}{d} = K\left[11+1.5\sqrt{fck}\frac{\rho o}{\rho-\rho'}+\frac{1}{12}\sqrt{fck}\sqrt{\frac{\rho'}{\rho}}\right]$$

$l/d = 1.0\ [\ 11 + (\ 1.5\ (25)^{1/2} \times 0.463) + 3.2 \times (25)^{1/2} \times (0.169)^{1/2}]$

$=1.0\ [11 + 3.47 + 6.58]$

$= 21.05$

Therefore basic span-effective depth ratio , l/d = 21.05

Modification factor for steel area provided,

Tension = As_{prov} / As_{req} = 1207/1200 = 1.005

Comp. = As_{prov} / As_{req} = 226/200 = 1.13

Example: Deflection

Therefore allowable span effective depth, (l/d)

allowable

$$(l/d)_{allowable} = 21.05 \times 1.005 \times 1.13 = 23.91$$

Actual span effective depth, $(l/d)_{actual}$

$$(l/d)_{actual} = 6000/450 = 13.33$$

$$(l/d)_{allowable} > (l/d)_{actual} \quad \text{(Pass!)}$$

Tutorial: Deflection

A simply supported rectangular beam spanning 3.5 m is 150 mm width and 265 mm effective depth. The area of tension steel required is 288 mm^2. 2H16 bars are provided for the tension reinforcement.

Verify for deflection consideration according EC2. Use concrete strength f_{ck} = 25 N/mm^2 and f_{yk} = 500 N/mm^2 for steel strength.

Tutorial: Detailing

1. Explain bond and anchorage.

2. What is the purpose of lapping of reinforcement? Tell the different ways how this can be achieved

Tutorial Session