FAQs

1. Explain the step by step procedure to design area of reinforcement required for the doubly reinforced rectangular section.

   First design the beam as a singly reinforced section (balanced section)

   i. Find x_c by

   $$\sigma_{cbc} / \sigma_{st}/m = x_c / d\text{-}x_c$$

   ii. Find A_{st1} by

   C = T

   $$bx_c\sigma_{cbc}/2 = \sigma_{st}A_{st1}$$

   iii. Find the Mr of singly reinforced balanced beam

   $$Mr = bx_c \sigma_{cbc}/2 (d\text{-}x_c/3)$$

   iv. Find the remaining bending moment, M_1

   $$M_1 = M - Mr$$

   v. Find A_{st2} for M_1

   $$M_1 = T \times \text{Lever arm}$$

   $$= A_{st2} \sigma_{st} (d\text{-}d^1)$$

   $$A_{st2} = M_1 / \sigma_{st} (d\text{-}d^1)$$

   vi. Find $A_{st} = A_{st1} + A_{st2}$

   vii. Find A_{sc}:

   Equating moments of equivalent area of tensile and compressive steel about N.A

   $$mA_{st2}(d\text{-}x_c) = (1.5m\text{-}1) A_{sc} (x_c\text{-}d^1)$$

2. A rectangular reinforced beam is 360mm x 750mm effective. The beam has to resist a bending moment of 300 kNm. Find the tensile and compressive steel required for the beam. Take σ_{cbc}=7 N/mm^2 σ_{st}=190 N/mm^2 and d'=50mm.

Solution:

Given

b	=	360mm
d	=	750mm
M_r	=	300 kNm
d^1	=	50mm
σ_{cbc}	=	7 N/mm^2
σ_{st}	=	190 N/mm^2
A_{st}	=	?
A_{sc}	=	?

i. Find x_c by

$$\sigma_{cbc} / \sigma_{st}/m = x_c / d\text{-}x_c$$

x_c = 247mm

for singly reinforced balanced section

ii. Find A_{st1} by

$C = T$

$bx_c\sigma_{cbc}/2 = \sigma_{st}A_{st1}$

A_{st1} = 1638 mm^2

iii. Find the Mr of singly reinforced balanced beam

$Mr = bx_c\ \sigma_{cbc}/2\ (d-x_c/3)$

Mr = 207.80 kNm

iv. Find the remaining bending moment, M_1

$M_1 = M - Mr$ = 92.20 kNm

v. Find A_{st2} for M_1

M_1 = T x Lever arm

$= A_{st2}\ \sigma_{st}\ (d-d^1)$

$A_{st2} = M_1 / \sigma_{st}\ (d-d^1)$ = 693.23 mm^2

vi. Find $A_{st} = A_{st1} + A_{st2}$ = 2331.23 mm^2

vii. Find A_{sc}:

Equating moments of equivalent area of tensile and compressive steel about N.A

$mA_{st2}(d-x_c) = (1.5m-1)\ A_{sc}\ (x_c-d^1)$

A_{sc} = 1242.14 mm^2

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3. A doubly reinforced concrete beam 250mm wide and 600mm deep overall has to resist an external bending moment of 95 kNm. Find the amount of tensile and compressive steel required, if cover to the centre of steel on both sides is 50mm. Take σ_{cbc}=5 N/mm^2 σ_{st}=140 N/mm^2

Solution:

Given

b	=	250mm
D	=	600mm
d	=	550mm
M_r	=	95 kNm
d^1	=	50mm
σ_{cbc}	=	5 N/mm^2
σ_{st}	=	140 N/mm^2
A_{st}	=	?
A_{sc}	=	?

i. Find x_c by

σ_{cbc} / $\sigma_{st}/m = x_c / d\text{-}x_c$

x_c = 219.95mm

for singly reinforced balanced section

ii. Find A_{st1} by

C = T

$bx_c\sigma_{cbc}/2 = \sigma_{st}A_{st1}$

A_{st1} = 982 mm^2

iii. Find the Mr of singly reinforced balanced beam

$Mr = bx_c\ \sigma_{cbc}/2\ (d\text{-}x_c/3)$

Mr = 65.54 kNm

iv. Find the remaining bending moment, M_1

$M_1 = M - Mr$ = 29.46 kNm

v. Find A_{st2} for M_1

M_1 = T x Lever arm

$= A_{st2}\ \sigma_{st}\ (d\text{-}d^1)$

$A_{st2} = M_1 / \sigma_{st}\ (d\text{-}d^1)$ = 421 mm^2

vi. Find $A_{st} = A_{st1} + A_{st2}$ = 1403 mm^2

vii. Find A_{sc}:

Equating moments of equivalent area of tensile and compressive steel about N.A

$mA_{st2}(d\text{-}x_c) = (1.5m\text{-}1)\ A_{sc}\ (x_c\text{-}d^1)$

A_{sc} = 565 mm^2