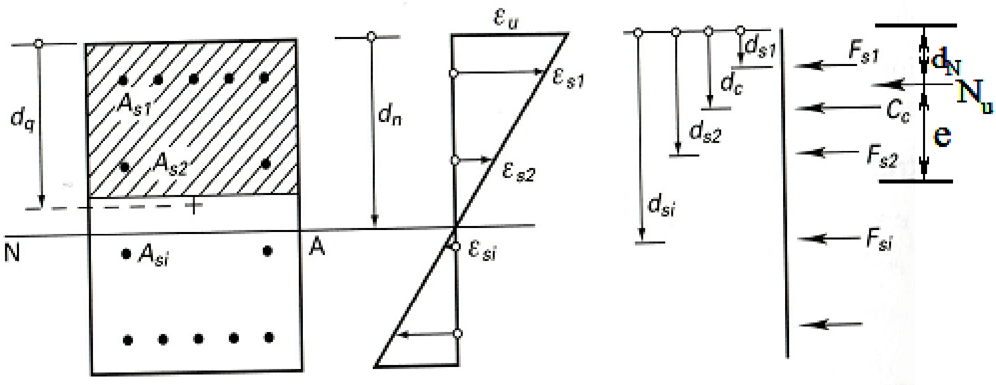
COLUMN DESIGN [AS3600- Normal Strength Concrete]

PROJECT : Corcon Test 1

COLUMN : Lower column

DESIGN DATA

$f_c = 47.4$	MPa	$A_{s1} := 800$	mm^2	$d_{s1} := 34$	mm
$f_{sy} = 442$	MPa	$A_{s2} := 400$	mm^2	$d_{s2} := 94.1$	mm
$D := 250$	mm	$A_{s3} := 400$	mm^2	$d_{s3} := 154.2$	mm
$b := 250$	mm	$A_{s4} := 800$	mm^2	$d_{s4} := 216$	mm
$E_s := 200000$	MPa				



CALCULATIONS

Compressive strain $\varepsilon_u := 0.003$ $\varepsilon_{sy} := \dfrac{f_{sy}}{E_s}$ $\varepsilon_{sy} = 0.0022$

Stress block parameter $\gamma := 0.85 - 0.007(f_c - 28)$ $\gamma = 0.714$ $0.65 \le \gamma \le 0.85$

Choose trial neutral axis $d_n := 89.375$

Stain in each layer of steel :

$\varepsilon_{s1} := \dfrac{\varepsilon_u}{d_n}\cdot(d_n - d_{s1})$ $\varepsilon_{s1} = 0.0019$ $\sigma_{s1} := if(|\varepsilon_{s1}| < \varepsilon_{sy}, E_s\cdot\varepsilon_{s1}, f_{sy})$

$\varepsilon_{s2} := \dfrac{\varepsilon_u}{d_n}\cdot(d_n - d_{s2})$ $\varepsilon_{s2} = -0.0002$ $\sigma_{s2} := if(|\varepsilon_{s2}| < \varepsilon_{sy}, E_s\cdot\varepsilon_{s2}, f_{sy})$

$\varepsilon_{s3} := \dfrac{\varepsilon_u}{d_n}\cdot(d_n - d_{s3})$ $\varepsilon_{s3} = -0.0022$ $\sigma_{s3} := if(|\varepsilon_{s3}| < \varepsilon_{sy}, E_s\cdot\varepsilon_{s3}, f_{sy})$

$\varepsilon_{s4} := \dfrac{\varepsilon_u}{d_n}\cdot(d_n - d_{s4})$ $\varepsilon_{s4} = -0.0043$ $\sigma_{s4} := if(|\varepsilon_{s4}| < \varepsilon_{sy}, E_s\cdot\varepsilon_{s4}, f_{sy})$

Steel stress is corrected for sign :

$\sigma_{s1} := if(\varepsilon_{s1} < 0 + |\varepsilon_{s1}| > \varepsilon_{sy}, -f_{sy}, \sigma_{s1})$ $\sigma_{s1} = 371.7$ MPa

$\sigma_{s4} := if(\varepsilon_{s2} < 0 + |\varepsilon_{s2}| > \varepsilon_{sy}, -f_{sy}, \sigma_{s2})$ $\sigma_{s2} = -31.7$ MPa

$\sigma_{s3} := if(\varepsilon_{s3} < 0 + |\varepsilon_{s3}| > \varepsilon_{sy}, -f_{sy}, \sigma_{s3})$ $\sigma_{s3} = -435.2$ MPa

$\sigma_{s4} := if(\varepsilon_{s4} < 0 + |\varepsilon_{s4}| > \varepsilon_{sy}, -f_{sy}, \sigma_{s4})$ $\sigma_{s4} = -442$ MPa

Concrete Compressive Force $C_c := 0.85 \cdot f_c \cdot \gamma \cdot b \cdot d_n \cdot 10^{-3}$ $C_c = 642.9$ kN

Forces in each layers of steel :

$F_{s1} := \sigma_{s1} \cdot A_{s1} \cdot 10^{-3}$ $F_{s1} = 297.4$ kN

$F_{s2} := \sigma_{s2} \cdot A_{s2} \cdot 10^{-3}$ $F_{s2} = -12.7$ kN

$F_{s3} := \sigma_{s3} \cdot A_{s3} \cdot 10^{-3}$ $F_{s3} = -174.1$ kN

$F_{s4} := \sigma_{s4} \cdot A_{s4} \cdot 10^{-3}$ $F_{s4} = -353.6$ kN

Concrete and steel forces are summed to give N_u

$N_u := C_c + F_{s1} + F_{s2} + F_{s3} + F_{s4}$ $N_u = 400$ kN

The eccentricity of N_u, d_N is given by taking moment about top compressive fibre :

$$d_N := \frac{\left[C_c \cdot (0.5 \cdot \gamma \cdot d_n) + F_{s1} \cdot d_{s1} + F_{s2} \cdot d_{s2} + F_{s3} \cdot d_{s3} + F_{s4} \cdot d_{s4}\right]}{N_u}$$ $d_N = -184.5$ mm

$$N_{uo} := \left[0.85 \cdot f_c \cdot b \cdot D + f_{sy} \cdot (A_{s1} + A_{s2} + A_{s3} + A_{s4})\right] \cdot 10^{-3}$$ $N_{uo} = 3578.9$ kN

Plastic Centroid d_q

$$d_q := \frac{1}{N_{uo}} \cdot \left[(0.85 \cdot f_c \cdot b \cdot D) \cdot 0.5 \cdot D + f_{sy} \cdot (A_{s1} \cdot d_{s1} + A_{s2} \cdot d_{s2} + A_{s3} \cdot d_{s3} + A_{s4} \cdot d_{s4})\right] \cdot 10^{-3}$$ $d_q = 124.916$ mm

Summing moments of forces about the plactic centroid :

$$M_u := \left[\begin{array}{l} C_c \cdot (d_q - 0.5 \cdot \gamma \cdot d_n) + F_{s1} \cdot (d_q - d_{s1}) + F_{s2} \cdot (d_q - d_{s2}) + F_{s3} \cdot (d_q - d_{s3}) \ldots \\ + F_{s4} \cdot (d_q - d_{s4}) \end{array}\right] \cdot 10^{-3}$$ $M_u = 123.7$ kNm

COLUMN : Upper column

DESIGN DATA

$f_c = 47.4$	MPa	$A_{s1} := 800$	mm^2	$d_{s1} := 34$	mm
$f_{sy} = 442$	MPa	$A_{s2} := 400$	mm^2	$d_{s2} := 94.1$	mm
$D := 250$	mm	$A_{s3} := 400$	mm^2	$d_{s3} := 154.2$	mm
$b := 250$	mm	$A_{s4} := 800$	mm^2	$d_{s4} := 216$	mm
$E_s := 200000$	MPa				

CALCULATIONS

Compressive strain $\varepsilon_u := 0.003$ $\quad \varepsilon_{sy} := \frac{f_{sy}}{E_s}$ $\quad \varepsilon_{sy} = 0.0022$

Stress block parameter $\gamma := 0.85 - 0.007(f_c - 28)$ $\quad \gamma = 0.714$ $\quad 0.65 \le \gamma \le 0.85$

Choose trial neutral axis $d_n := 85.21$

Stain in each layer of steel :

$$\varepsilon_{s1} := \frac{\varepsilon_u}{d_n}\cdot(d_n - d_{s1}) \qquad \varepsilon_{s1} = 0.0018 \qquad \sigma_{s1} := if(|\varepsilon_{s1}| < \varepsilon_{sy}, E_s\cdot\varepsilon_{s1}, f_{sy})$$

$$\varepsilon_{s2} := \frac{\varepsilon_u}{d_n}\cdot(d_n - d_{s2}) \qquad \varepsilon_{s2} = -0.0003 \qquad \sigma_{s2} := if(|\varepsilon_{s2}| < \varepsilon_{sy}, E_s\cdot\varepsilon_{s2}, f_{sy})$$

$$\varepsilon_{s3} := \frac{\varepsilon_u}{d_n}\cdot(d_n - d_{s3}) \qquad \varepsilon_{s3} = -0.0024 \qquad \sigma_{s3} := if(|\varepsilon_{s3}| < \varepsilon_{sy}, E_s\cdot\varepsilon_{s3}, f_{sy})$$

$$\varepsilon_{s4} := \frac{\varepsilon_u}{d_n}\cdot(d_n - d_{s4}) \qquad \varepsilon_{s4} = -0.0046 \qquad \sigma_{s4} := if(|\varepsilon_{s4}| < \varepsilon_{sy}, E_s\cdot\varepsilon_{s4}, f_{sy})$$

Steel stress is corrected for sign :

$$\sigma_{s1} := if(\varepsilon_{s1} < 0 + |\varepsilon_{s1}| > \varepsilon_{sy}, -f_{sy}, \sigma_{s1}) \qquad \sigma_{s1} = 360.6 \quad MPa$$

$$\sigma_{s4} := if(\varepsilon_{s2} < 0 + |\varepsilon_{s2}| > \varepsilon_{sy}, -f_{sy}, \sigma_{s2}) \qquad \sigma_{s2} = -62.6 \quad MPa$$

$$\sigma_{s3} := if(\varepsilon_{s3} < 0 + |\varepsilon_{s3}| > \varepsilon_{sy}, -f_{sy}, \sigma_{s3}) \qquad \sigma_{s3} = -442 \quad MPa$$

$$\sigma_{s4} := if(\varepsilon_{s4} < 0 + |\varepsilon_{s4}| > \varepsilon_{sy}, -f_{sy}, \sigma_{s4}) \qquad \sigma_{s4} = -442 \quad MPa$$

Concrete Compressive Force $\quad C_c := 0.85\cdot f_c\cdot\gamma\cdot b\cdot d_n\cdot 10^{-3}$ $\quad C_c = 613 \quad kN$

Forces in each layers of steel :

$$F_{s1} := \sigma_{s1}\cdot A_{s1}\cdot 10^{-3} \qquad F_{s1} = 288.5 \quad kN$$

$$F_{s2} := \sigma_{s2}\cdot A_{s2}\cdot 10^{-3} \qquad F_{s2} = -25 \quad kN$$

$$F_{s3} := \sigma_{s3}\cdot A_{s3}\cdot 10^{-3} \qquad F_{s3} = -176.8 \quad kN$$

$$F_{s4} := \sigma_{s4}\cdot A_{s4}\cdot 10^{-3} \qquad F_{s4} = -353.6 \quad kN$$

Concrete and steel forces are summed to give N_u

$$N_u := C_c + F_{s1} + F_{s2} + F_{s3} + F_{s4}$$ $N_u = 346$ kN

The eccentricity of N_u, d_N is given by taking moment about top compressive fibre :

$$d_N := \frac{\left[C_c \cdot (0.5 \cdot \gamma \cdot d_n) + F_{s1} \cdot d_{s1} + F_{s2} \cdot d_{s2} + F_{s3} \cdot d_{s3} + F_{s4} \cdot d_{s4}\right]}{N_u}$$ $d_N = -224.1$ mm

$$N_{uo} := \left[0.85 \cdot f_c \cdot b \cdot D + f_{sy} \cdot (A_{s1} + A_{s2} + A_{s3} + A_{s4})\right] \cdot 10^{-3}$$ $N_{uo} = 3578.9$ kN

Plastic Centroid d_q

$$d_q := \frac{1}{N_{uo}} \cdot \left[(0.85 \cdot f_c \cdot b \cdot D) \cdot 0.5 \cdot D + f_{sy} \cdot (A_{s1} \cdot d_{s1} + A_{s2} \cdot d_{s2} + A_{s3} \cdot d_{s3} + A_{s4} \cdot d_{s4})\right] \cdot 10^{-3}$$ $d_q = 124.916$ mm

Summing moments of forces about the plactic centroid :

$$M_u := \left[C_c \cdot (d_q - 0.5 \cdot \gamma \cdot d_n) + F_{s1} \cdot (d_q - d_{s1}) + F_{s2} \cdot (d_q - d_{s2}) + F_{s3} \cdot (d_q - d_{s3}) \ldots + F_{s4} \cdot (d_q - d_{s4})\right] \cdot 10^{-3}$$ $M_u = 120.8$ kNm

BEAM DESIGN [AS3600- Normal Strength Concrete]

PROJECT : Corcon Test 1

**BEAM : ** 250x250 Column

DESIGN DATA

$f_c = 47.4$	MPa				
$f_{sy} = 442$	MPa	$E_s := 200000$	MPa	$f_{syf} = 345$	MPa
$D := 250$	mm	$d_o := 216$	mm	$s := 175$	mm
$b := 250$	mm	$b_t := 250$	mm	$A_g := 62500$	mm^2
$A_{st} := 800$	mm^2	$d_{sc} := 34$	mm	$A_{sv} := 56$	mm^2
$A_{sc} := 800$	mm^2	$N := 346$	kN		

Design for Shear

(a) Calculation of Vuc

$$\beta_1 := 1.1 \cdot \left(1.6 - \frac{d_o}{1000}\right) \qquad \beta_1 = 1.522$$

$$\beta_2 := 1 + \frac{N \cdot 10^3}{14 \cdot A_g}$$ For members with Compressive axial force

$$\beta_2 = 1.395$$

$$\beta_3 := 1$$ (As there is no Concentrated load near the support)

$$b_v := 0.5 \cdot (b + b_t)$$

$$V_{uc} := \beta_1 \cdot \beta_2 \cdot \beta_3 \cdot b_v \cdot d_o \left(\frac{A_{st} \cdot f_c}{b_v \cdot d_o}\right)^{\frac{1}{3}} \cdot 10^{-3} \qquad V_{uc} = 102 \text{ kN}$$

(b) Calculation of θv

$A_{sv} = 56$ mm^2

$A_{svmin} := 0.35 \cdot b_v \cdot \frac{s}{f_{syf}}$ $A_{svmin} = 44.384$ mm^2

$A_{svmax} := b_v \cdot \frac{s}{f_{syf}} \left(0.2 \cdot f_c - \frac{V_{uc} \cdot 10^3}{b_v \cdot d_o} \right)$ $A_{svmax} = 962.7$ mm^2

$\theta_v := 30 + 15 \cdot \left(\frac{A_{sv} - A_{svmin}}{A_{svmax} - A_{svmin}} \right)$ $\theta_v = 30.2$ deg

$\theta_{vr} := \theta_v \cdot \frac{\pi}{180}$

(c) Calculation of ϕVu when stirrups are at yield

$V_{us} := \frac{A_{sv}}{s} \cdot f_{syf} \cdot d_o \cdot \cot(\theta_{vr}) \cdot 10^{-3}$ $V_{us} = 40.989$

$V_u := V_{uc} + V_{us}$ $V_u = 143$ kN

$\phi := 0.7$ Therefore Shear Strength $\phi \cdot V_u = 100.1$ kN