BEAM DESIGN CACULATION- B1

Data-Beam B1

Material C40/50,	$f_{ck} := 40\frac{N}{mm^2}$	$f_y := 460\frac{N}{mm^2}$
$b_w := 150mm$	$D := 450mm$	$d_c := 25mm$
Span of beam,		$L := 2.57m$
Floor Finish(Stone Finish, 50Bed, Ceiling),	$W_{ff} := \left[(0.5 + 1 + 0.15)\frac{kN}{m^2}\right]$	
Unit weight of concrete,	$\gamma := 25\frac{kN}{m^3}$	
Live load on Slab	$W_f := 1.5\frac{kN}{m^2}$	
Thickness of Ground Floor Slab,	$D_{slab} := 225mm$	
Total load of internal block wall,		$W_{bw} := 3.45\frac{kN}{m^2}$
Height of internal block wall,		$H_{bw} := 3.005m$

Load calculations on Beam B1

Ultimate Load from block wall, (due to selfweight)	$UL_{wall} := 1.35(H_{bw} \cdot W_{bw})$	$UL_{wall} = 14 \cdot \frac{kN}{m}$
Contributary span of slab, for beam	$Span := \frac{2.56m}{2} + 0.8m$	$Span = 2.08\,m$
Dead Load from GF slab,(DL)	$DL_f := D_{slab} \cdot \gamma \cdot Span + W_{ff} \cdot Span$	$DL_f = 15.132 \cdot \frac{kN}{m}$
Live Load from GF slab,(LL)	$LL_f := W_f \cdot Span$	$LL_f = 3.12 \cdot \frac{kN}{m}$
Ultimate Load from GF slab, (due to DL & LL)	$UL_{slab} := 1.35 \cdot (DL_f) + 1.5(LL_f)$	$UL_{slab} = 25.108 \cdot \frac{kN}{m}$
Ultimate Load from beam, (due to selfweight)	$UL_{beam} := 1.35 \cdot (b_w \cdot D \cdot \gamma)$	$UL_{beam} = 2.3 \cdot \frac{kN}{m}$
Ultimate Load on beam, (due to slab & wall above)	$UL_{total} := UL_{wall} + UL_{slab} + UL_{beam}$	$UL_{total} = 41.4 \cdot \frac{kN}{m}$
Maximum moment,	$M_u := \frac{UL_{total} \cdot L^2}{8}$	$M_u = 34.2 \cdot kN \cdot m$
Maximum shear,	$Q_u := \frac{UL_{total} \cdot L}{2}$	$Q_u = 53.2 \cdot kN$

Flexure Reinforcement

$d := D - d_c$ $\quad d = 425 \cdot mm$ $\quad d1 := d - d_c$ $\quad d1 = 400 \cdot mm$

Limiting Moment, $M_{ulim} := 0.167 \cdot f_{ck} \cdot b_w \cdot d^2$ $\quad M_{ulim} = 181 \cdot kN \cdot m$

$M_{comp} := \max[(M_u - M_{ulim}), 0]$ $\quad M_{comp} = 0 \cdot kN \cdot m$

$M_u < M_{ulim}$ so compression reinforcement is not required

Compression reinforcement, $A_{sc} := \frac{M_{comp}}{0.87 f_y \cdot d1}$ $\quad A_{sc} = 0 \cdot mm^2$

Tension reinforcement,

$M_{des} := \min(M_u, M_{ulim})$ $\quad M_{des} = 34.2 \cdot kN \cdot m$

$k := \frac{M_{des}}{b_w \cdot d^2 \cdot f_{ck}}$ $\quad k = 0.032$

Lever arm $l_a := 0.5 + \sqrt{0.25 - \frac{k}{0.908}}$ $\quad l_a = 0.964$

$l_{amax} := \text{if}(l_a < 0.95, l_a, 0.95)$

$A_{st} := \left(\frac{M_{des}}{l_{amax} \cdot d \cdot 0.87 \cdot f_y}\right) + A_{sc}$ $\quad A_{st} = 211.4 \cdot mm^2$

Provide $n := 2$ **nos** $\phi := 16mm$ **dia** $\quad A_{s1} := n \cdot \frac{\pi \cdot \phi^2}{4}$ $\quad A_{s1} = 402.124 \cdot mm^2$

Shear Reinforcement

Flexural Reinforcement $A_{s1} = 402.124 \cdot mm^2$

$\rho := \text{if}\left(\frac{A_{s1}}{b_w \cdot d} \le 0.02, \frac{A_{s1}}{b_w \cdot d}, 0.02\right)$ $\quad \rho = 6.308 \times 10^{-3}$

$\upsilon := 0.699 - \frac{f_{ck} \cdot \frac{mm^2}{N}}{200}$

$\upsilon = 0.499$ $\quad \upsilon := \text{if}(\upsilon < 0.5, 0.5, \upsilon)$

$v_{max} := 0.3 \cdot \upsilon \cdot f_{ck}$ $\quad v_{max} = 6 \cdot \frac{N}{mm^2}$

$v_c = 0.689 \cdot \frac{N}{mm^2}$

$V_{Rd2} := v_{max} \cdot b_w \cdot d$ $V_{Rd2} = 382.5 \cdot kN$

$V_{Rd3} := Q_u$

Applied shear stress $v := \frac{V_{Rd3}}{b_w \cdot d}$ $v = 0.834 \cdot \frac{N}{mm^2}$ (Shear reinforcement to be provided)

Assuming stirrups dia, $\phi_1 := 8mm$ at spacing, $s := 250mm$

$A_{sw.req} := 1.28 (v - v_c) \cdot \frac{b_w \cdot s}{f_y}$ $A_{sw.req} = 15.136 \cdot mm^2$

$A_{swprov} := 2 \cdot \frac{\pi \cdot \phi_1^2}{4}$ $A_{swprov} = 100.531 \cdot mm^2$