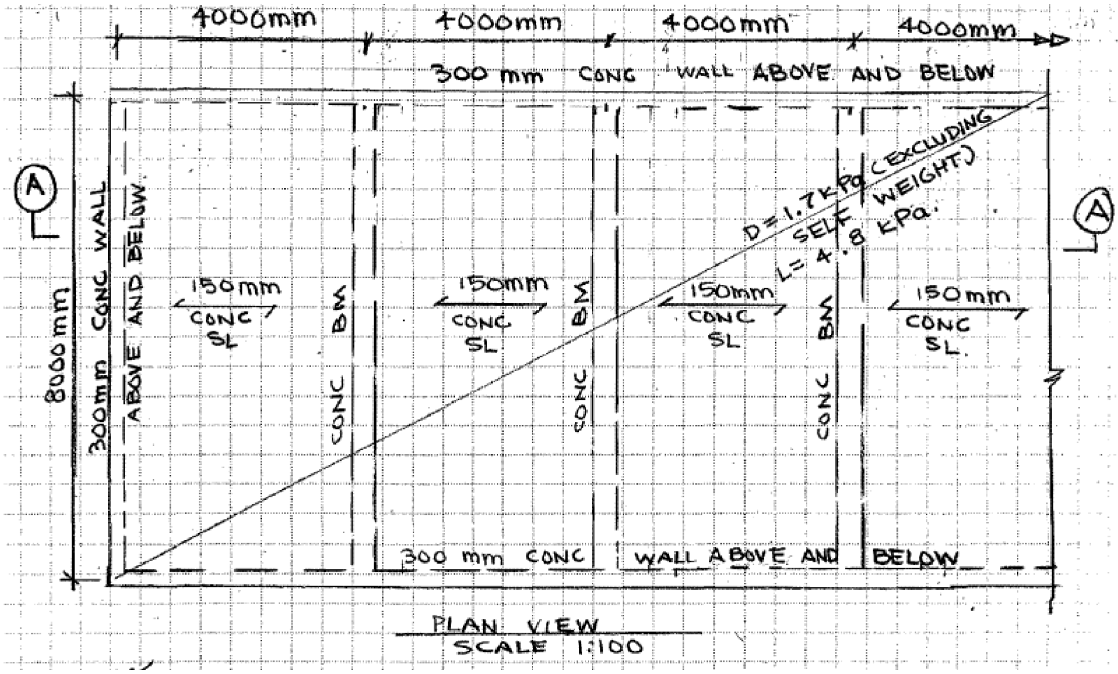

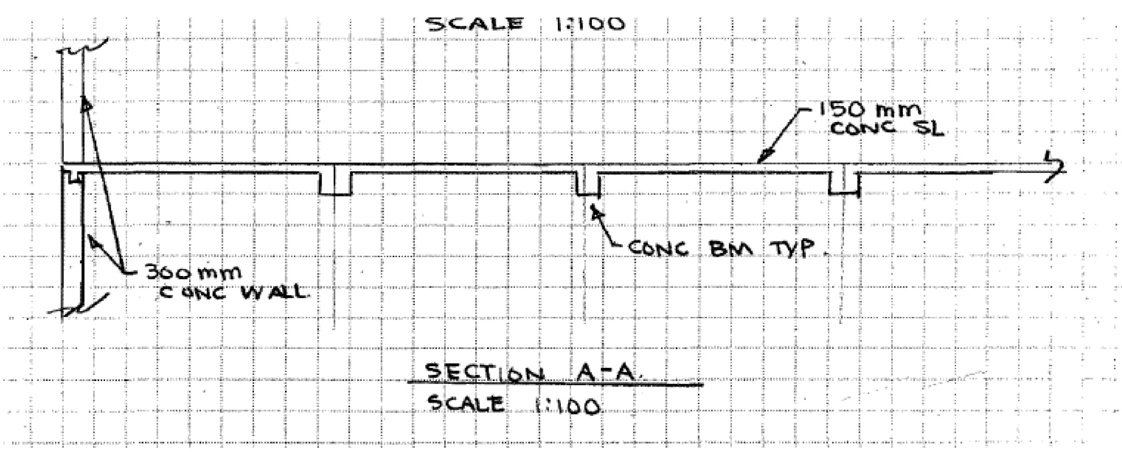

$\text{Dead}_{\text{load}} := 1.7\text{kPa}$ $\text{Live}_{\text{load}} := 4.8\text{kPa}$ $\gamma_{\text{conc}} := 23.6\,\frac{\text{kN}}{\text{m}^3}$

not including conc weight

$\text{Dead}_{\text{load}} + .15\text{m}\cdot\gamma_{\text{conc}} = 5.24\cdot\text{kPa}$ $l := 4000\text{mm}$

SLAB

maximum downward (gravity loads)

ULS factored loads

Given

dead	live	snow	earthquake	wind
$D := 5.24kPa$	$L := 4.8kPa$	$S := 0kPa$	$E := 000kPa$	$W := 000kPa$

step 1 gravity loads are +ve Upward loads are -ve

CASE 1 =	$C_1 := 1.4 \cdot D$	$C_1 = 7.336 \times 10^3 \, Pa$
CASE 2a =	$C_{2a} := (1.25 \cdot D) + (1.5 \cdot L) + 0.5S$	$C_{2a} = 1.375 \times 10^4 \, Pa$
CASE 2b =	$C_{2b} := (1.25 \cdot D) + (1.5 \cdot L) + 0.4W$	$C_{2b} = 1.375 \times 10^4 \, Pa$
CASE 3a =	$C_{3a} := (1.25 \cdot D) + (1.5 \cdot S) + 0.5L$	$C_{3a} = 8.95 \times 10^3 \, Pa$
CASE 3b =	$C_{3b} := (1.25 \cdot D) + (1.5 \cdot S) + 0.4W$	$C_{3b} = 6.55 \times 10^3 \, Pa$
CASE 4a =	$C_{4a} := (1.25 \cdot D) + (1.4 \cdot W) + 0.5L$	$C_{4a} = 8.95 \times 10^3 \, Pa$
CASE 4b =	$C_{4b} := (1.25 \cdot D) + (1.4 \cdot W) + 0.5S$	$C_{4b} = 6.55 \times 10^3 \, Pa$

$$max_{total} := \max\left(C_1, C_{2a}, C_{2b}, C_{3a}, C_{3b}, C_{4a}, C_{4b}\right)$$

$max_{total} = 13.75 \cdot kPa$ consider 1m section

150 = depth 20 = cover 11.3/2 = rebardia/2

step 2

$$M_f := \frac{\left(max_{total} \cdot 1m\right) \cdot l^2}{8}$$

$b := 1000mm$

$d := 150mm - 20mm - \frac{11.3mm}{2}$

$t := 150mm$

$M_f = 27.5 \, m \cdot kN$

step 3

$K_r := \frac{M_f}{b \cdot d^2}$ $\quad F_y := 400MPa$ $\quad F_{cprime} := 20MPa$

$K_r = 1.778 \cdot MPa$ goto excell based on Kr now

$\rho := 0.58\%$ from excel step 4

$A_s := \rho \cdot b \cdot d$ step 5

$A_s = 721.23 \cdot mm^2$

check for minimim area

$A_{smin} := 0.002 \cdot (b \cdot t)$ step 6

slab or footing

$A_{smin} = 300 \cdot mm^2$

$A_s \geq A_{smin} = 1$

$max_{used} := max(A_{smin}, A_s)$

$max_{used} = 721.23 \cdot mm^2$ step 7

$bar_{number} := \frac{A_s}{100mm}$

$bar_{number} = 7.212 \cdot mm$ number of bars step 8

$bar_{spacing} := \frac{b}{7.21}$

$bar_{spacing} = 138.696 \cdot mm$ therefore 130mm offset step 9

$a_{max} := 1.4(20mm)$ $d_b := 1.4 \cdot 11.3mm$ $dia_{rebar} := 1.4 \cdot 11.3mm$

$a_{max} = 28 \cdot mm$ $d_b = 15.82 \cdot mm$ $dia_{rebar} = 15.82 \cdot mm$

step 10 = how many bars @ barspacing with location (bottom/top)

step 11

clear bar spacing minimum

$bar_{spacing} \geq d_b = 1$

$bar_{spacing} \geq a_{max} = 1$

$bar_{spacing} \geq 30mm = 1$

step 12

maximum

$$principle_{spacing} \leq \begin{pmatrix} 3 \cdot t \\ 500mm \end{pmatrix}$$

$bar_{spacing} \leq 3 \cdot t = 1$

$bar_{spacing} \leq 500mm = 1$

Step 13 crack control

$F_y = 400 \cdot MPa$

$f_c := 0.6 \cdot F_y$

$f_c = 240 \cdot MPa$

$$A := \frac{\left(20mm + \frac{11.3mm}{2}\right) \cdot 2}{bar_{number}}$$

$A = 7.113$

Question 2 BEAMS

$Dead_{load} := 1.7kPa$ $Live_{load} := 4.8kPa \cdot 4m$ $\gamma_{conc} := 23.6 \frac{kN}{m^3}$ $l := 8000mm$

not including conc weight $Live_{load} = 19.2 \cdot \frac{kN}{m}$

$$Dead_{load} \cdot 4m + \left[(.15m \cdot 4m) \cdot \gamma_{conc}\right] + \left[0.4m \cdot (.65m - .15m) \cdot \gamma_{conc}\right] = 25.68 \cdot \frac{kN}{m}$$

dead load concrete weight

maximum downward (gravity loads)

ULS factored loads

Given

dead	live	snow	earthquake	wind
$D := 25.68 \frac{kN}{m}$	$L := 19.2 \frac{kN}{m}$	$S := 0 \frac{kN}{m}$	$E := 000 \frac{kN}{m}$	$W := 000 \frac{kN}{m}$

step 1 gravity loads are +ve Upward loads are -ve

CASE 1 =	$C_1 := 1.4 \cdot D$	$C_1 = 3.595 \times 10^4 \frac{kg}{s^2}$
CASE 2a =	$C_{2a} := (1.25 \cdot D) + (1.5 \cdot L) + 0.5S$	$C_{2a} = 6.09 \times 10^4 \frac{kg}{s^2}$
CASE 2b =	$C_{2b} := (1.25 \cdot D) + (1.5 \cdot L) + 0.4W$	$C_{2b} = 6.09 \times 10^4 \frac{kg}{s^2}$
CASE 3a =	$C_{3a} := (1.25 \cdot D) + (1.5 \cdot S) + 0.5L$	$C_{3a} = 4.17 \times 10^4 \frac{kg}{s^2}$
CASE 3b =	$C_{3b} := (1.25 \cdot D) + (1.5 \cdot S) + 0.4W$	$C_{3b} = 3.21 \times 10^4 \frac{kg}{s^2}$
CASE 4a =	$C_{4a} := (1.25 \cdot D) + (1.4 \cdot W) + 0.5L$	$C_{4a} = 4.17 \times 10^4 \frac{kg}{s^2}$
CASE 4b =	$C_{4b} := (1.25 \cdot D) + (1.4 \cdot W) + 0.5S$	$C_{4b} = 3.21 \times 10^4 \frac{kg}{s^2}$

$$max_{total} := \max(C_1, C_{2a}, C_{2b}, C_{3a}, C_{3b}, C_{4a}, C_{4b})$$

$$max_{total} = 60.9 \cdot \frac{kN}{m}$$

consider 1m section

step 2

650 = depth   30 = cover 11.3/2 = rebardia/2

$M_f := \frac{(max_{total}) \cdot l^2}{8}$ $b := 400mm$ $d := 650mm - 30mm - 11.3mm - \frac{29.9mm}{2} - 2$

$t := 150mm$ $d = 563.79 \cdot mm$

$M_f = 487.2 \, m \cdot kN$

step 3

$K_r := \frac{M_f}{b \cdot d^2}$ $F_y := 400MPa$ $F_{cprime} := 20MPa$

$K_r = 3.832 \cdot MPa$ goto excell based on Kr now

$\rho := 1.47\%$ from excel   step 4

$A_s := \rho \cdot b \cdot d$ step 5

$A_s = 3315.085 \cdot mm^2$

$A_{smin} := 0.2 \cdot \frac{\sqrt{\frac{F_c}{MPa}} \cdot b \cdot d_1}{\frac{F_y}{MPa}}$ $F_c := 20MPa$ $F_y = 400 \cdot MPa$ $b_t := b$ $d_1 := 650mm$

$b = 400 \cdot mm$

step 6   for a beam

$A_{smin} = 581.378 \cdot mm^2$

$A_s \geq A_{smin} = 1$

$max_{used} := max(A_{smin}, A_s)$

$max_{used} = 3315.085 \cdot mm^2$ step 7

$bar_{number} := \frac{A_s}{700mm}$ divide by area of the bar $A1 = 702.154 \cdot mm^2$ AREA of bar use

$bar_{number} = 4.736 \cdot mm$ number of bars step 8

$bar_{spacing} := \frac{b}{5}$

$bar_{spacing} = 80 \cdot mm$ therefore 80mm offset step 9

$a_{max} := 1.4(30mm)$ $d_b := 1.4 \cdot 11.3mm$ $dia_{rebar} := 1.4 \cdot 11.3mm$

$a_{max} = 42 \cdot mm$ $d_b = 15.82 \cdot mm$ $dia_{rebar} = 15.82 \cdot mm$

step 10 = how many bars @ barspacing with location (bottom/top)

step 11

clear bar spacing minimum

$bar_{spacing} \geq d_b = 1$

$bar_{spacing} \geq a_{max} = 1$

$bar_{spacing} \geq 30mm = 1$

step 12

maximum

$principle_{spacing} \leq \begin{pmatrix} 3 \cdot t \\ 500mm \end{pmatrix}$

$bar_{spacing} \leq 3 \cdot t = 1$

$bar_{spacing} \leq 500mm = 1$

Step 13 crack control

$F_y = 400 \cdot MPa$

$f_c := 0.6 \cdot F_y$

$f_c = 240 \cdot MPa$

$d_c := 30mm + 11.3mm + \frac{29.9mm}{2}$

$d_c = 56.25 \cdot mm$

y is equal to d.c if one layer if two layer use y

$$y := 30mm + 11.3mm + \frac{29.9mm}{2} + 29.96mm$$

$$y = 86.21 \cdot mm$$

$$A := \frac{2 \cdot y \cdot b}{5}$$

$$A = 13793.6 \cdot mm^2$$

$$Z := \frac{f_c}{MPa} \cdot \sqrt[3]{\frac{d_c \cdot A}{mm \cdot mm^2}} \cdot 10^{-3}$$

$$Z = 22.054$$

Size	Nominal Diameter (mm)	Mass (kg/m)	Area (mm2)	Common Uses
10M	11.3	0.785	100	Beam stirrups, column ties, slab/wall/footing longitudinal reinforcing.
15M	16.0	1.570	200	
20M	19.5	2.355	300	Slab/wall/beam/column/ footing longitudinal reinforcing.
25M	25.2	3.925	500	
30M	29.9	5.495	700	Beam/column longitudinal reinforcing.
35M	35.7	7.850	1000	
45M	43.7	11.775	1500	Column longitudinal reinforcing.
55M	56.4	56.4	2500	

9.96mm

$$A1 := \frac{\pi \cdot (29.9mm)^2}{4}$$

$$A2 := \frac{\pi \cdot (29.9mm)^2}{4}$$

$A1 = 702.154 \cdot mm^2$

$A2 = 702.154 \cdot mm^2$

$A1 \cdot 3 = 2106.461 \cdot mm^2$

$A2 \cdot 2 = 1404.308 \cdot mm^2$

$A_{sum} := (A1 \cdot 3) + (A2 \cdot 2)$

$A_y := (A2 \cdot 2) \cdot (29.9mm + 45mm)$

$A_{sum} = 3.511 \times 10^3 \cdot mm^2$

$A_y = 105182.641 \cdot mm^3$

$$Y_c := \frac{A_y}{A_{sum}}$$

$Y_c = 29.96 \cdot mm$

from center of the bottom bar

value of max for A.s