Cap design

$f'_c = 28\ Mpa\ ,\ f_y = 428\ Mpa$

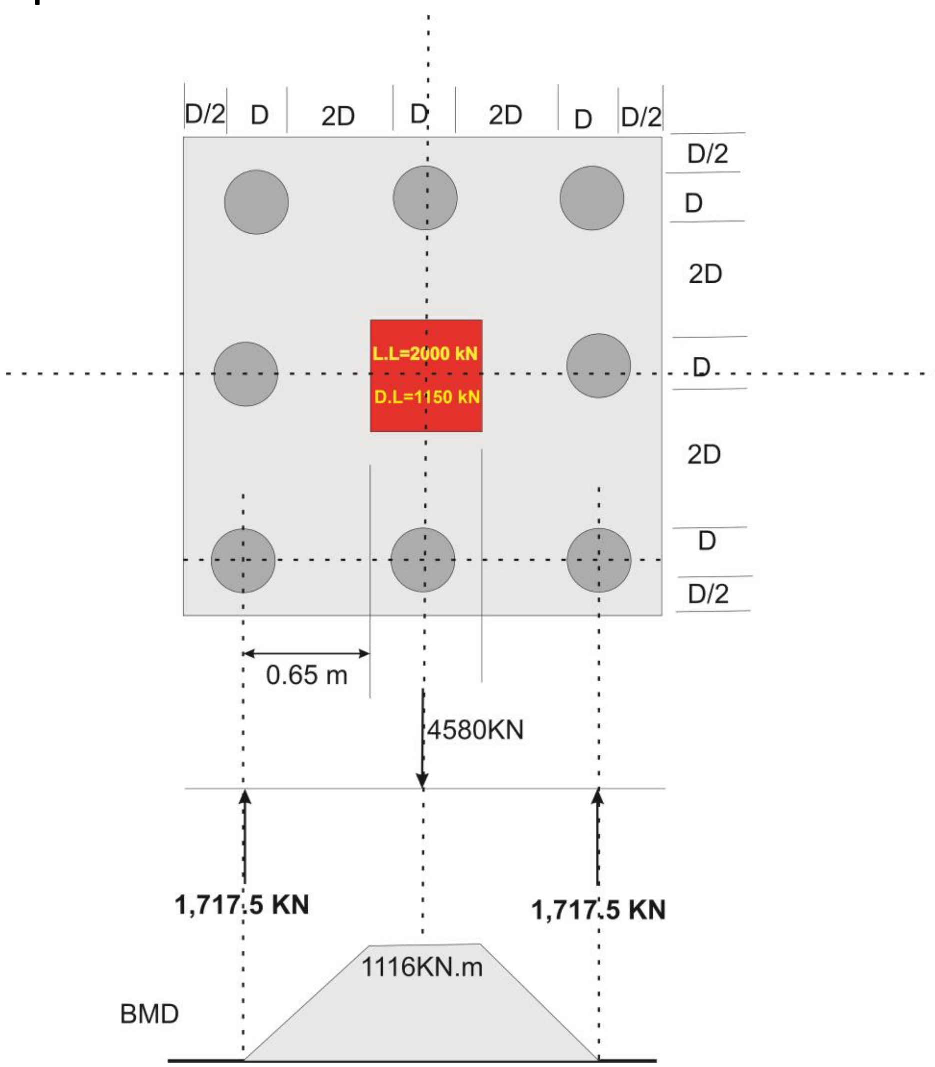
$L.L = 2000\ KN\ ,\ D.L = 1150\ KN$

$D\ = 300mm,$ **Piles are embedded into the cap 100mm**

Column dimensions 500mm*500mm

Cap dimension design

The plan dimensions of a pile cap depend on the number of piles that are needed to support the load. Number and arrangement of piles were determined from unfactored forces and moments transmitted to piles and permissible pile capacity selected through geotechnical engineering principles.



$$L = \frac{D}{2} + D + 2D + D + 2D + D + \frac{D}{2} = 8D = 8 * 300m = 2400mm$$

Pile Thickness

1- **Two-way shear requirements around the column.**

$$P_U = 1.2\ D.L + 1.6\ L.L$$

$$P_U = 1.2 * 1150 + 1.6 * 2000 = 4580\ KN$$

$$U = b_O d\emptyset\ (0.34)\ \sqrt{f_C'}$$

$$4580 = 4(d + 0.5)d * 0.75 * 1000 * \sqrt{28}$$

$0.2885 = (d + 0.5)d$ **, d = 0.34 m say 350mm < 300 mm minimum cap thichkness**

2- **One-way and two-way shear requirements around the piles.**

$$P_U\ \ for\ pile = \frac{4580\ KN}{8} = 572.5\ KN$$

$$b_O = \pi(D + d)$$
$$b_O = \pi(0.3 + d)$$
$$P_U = b_O d\emptyset\ (0.34)\ \sqrt{f_C'}$$
$$572.5 = \pi(0.3 + d)d * 0.75 * 0.34 * 1000 * \sqrt{28}$$

$(0.3 + d)d$ ***= 0.135 , d = 0.25m = 250 mm take 350 mm***

Reinforcement calculation

The factored moment at the critical section is obtained by multiplying the reactions from three piles by the distance from the center of the piles to the critical section (at the face of the column) as follows:

$$M_U = 1717.5\ KN * 0.65m = 1,116\ KN.m$$

$$d = 0.35\ m$$

$a = \frac{A_S f_y}{0.85 f_C b} = \frac{\rho d f_y}{0.85 f_C}$ ……………………………….***(1)***

$\rho = \frac{A_S}{bd}$ ……………………………….***(2)***

$M_U = \emptyset A_S f_y (d - \frac{a}{2})$ ....(3)

$M_U = \emptyset \rho b d f_y (d - \frac{\rho d f_y}{1.7 f_C})$ ....(4)

$a = \frac{A_S f_y}{0.85 f_C\, b} = \frac{\rho d f_y}{0.85 f_C} = \frac{\rho * 0.35 * 428}{0.85 * 28} = 6.294\rho$ *sub in (4)*

$1116 = 0.85 * \rho * 0.35 * 2.4 * 428 * 100(0.35 - \frac{\rho * 0.35 * 428}{1.7 * 28})$

0.00365 $= \rho(0.35 -$ *3.147*$\rho)$, $\rho = 0.01$

From (2)

$0.01 = \frac{A_S}{2400 * 350}$, $A_S = 8400\ mm2$, $Bars\ No. = 17.14$ *say 18*$\emptyset$*25mm in two directions*