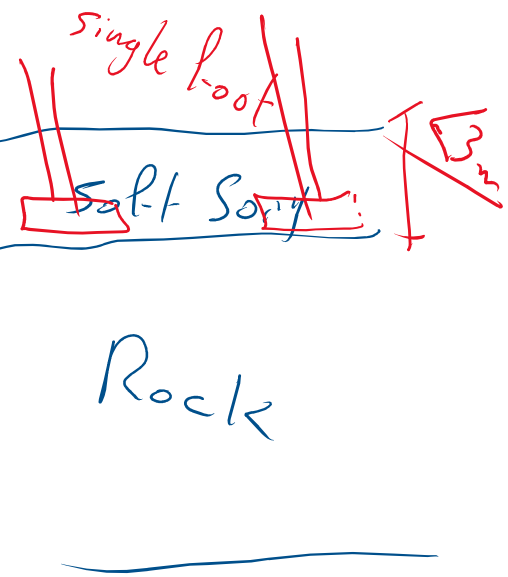
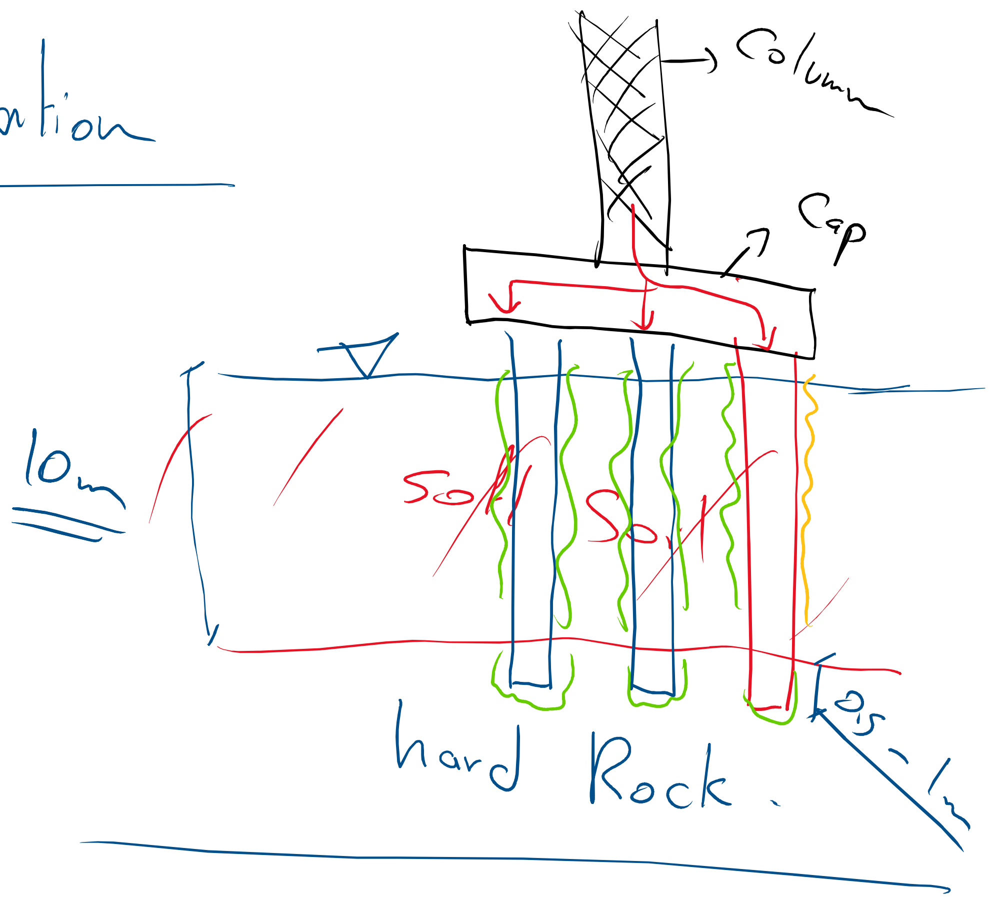
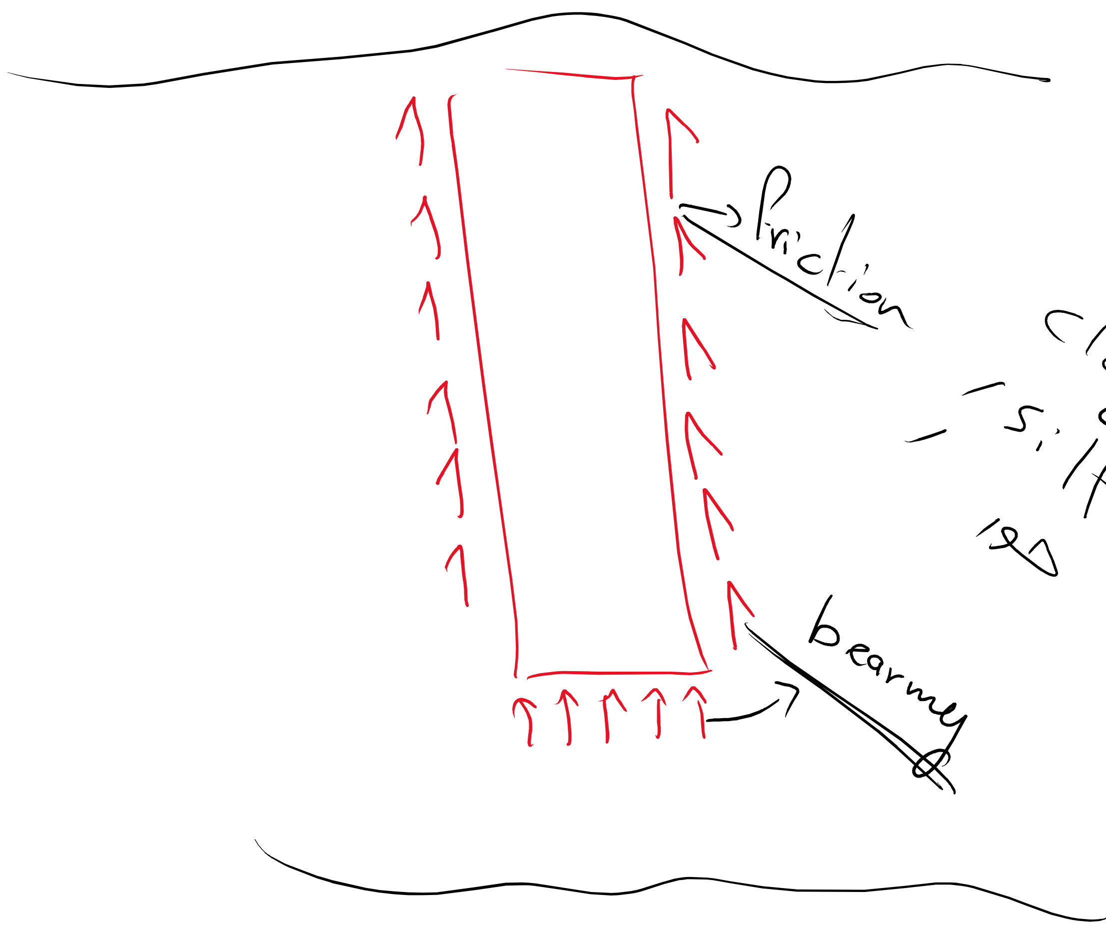
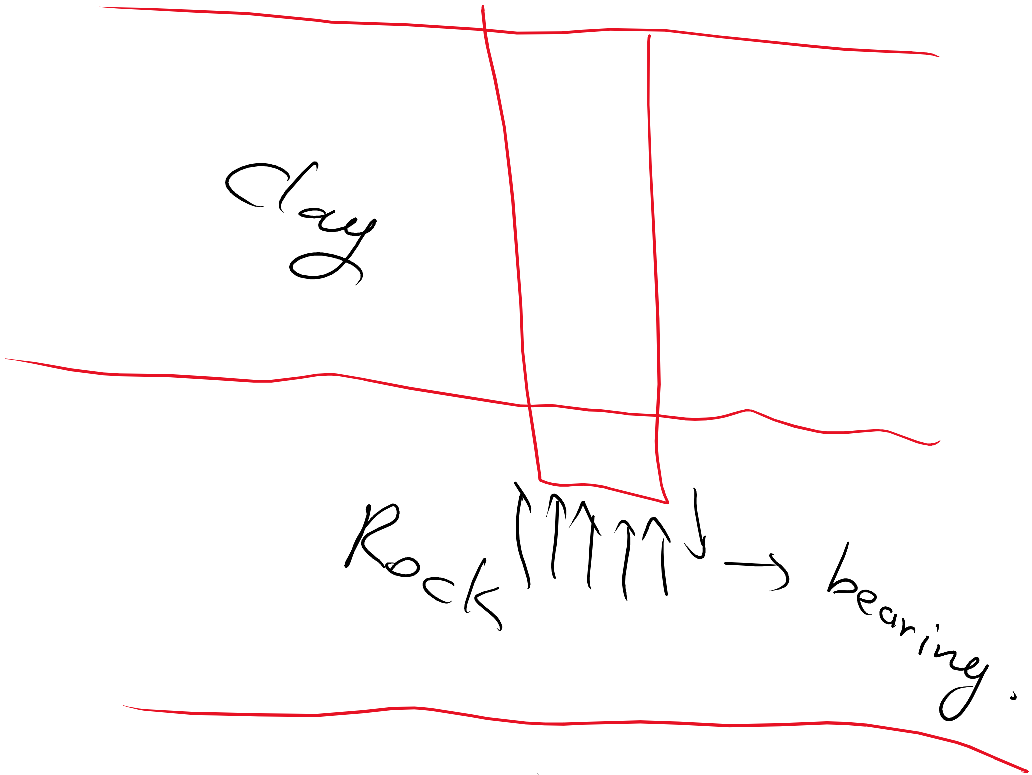
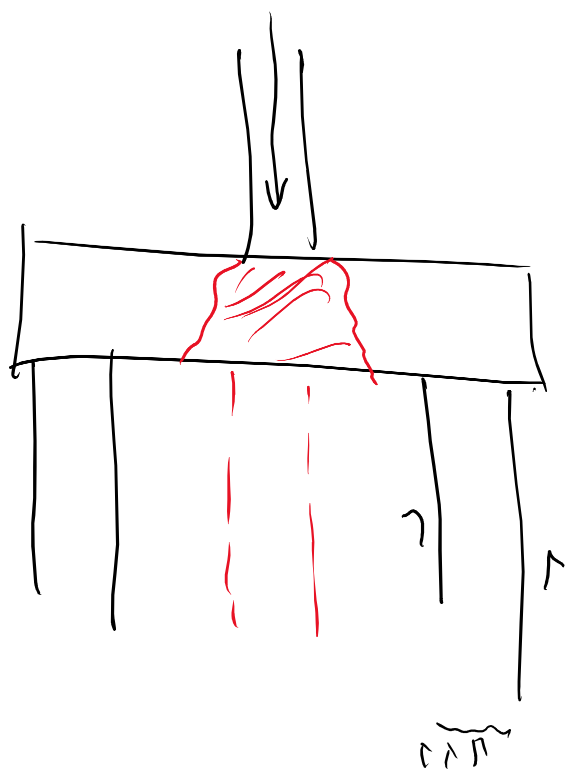
# Pile foundation




Clay
Rock
→ bearing.



# Design Steps

① number of Pile required.

example of soil report

| Length | Pile Dia | Capacity. |
|---|---|---|
| 5 m | 50 | 1000 kN. |
| | 60 | 1100 |
| | 70 | 1200 |
| | 80 | 1300 |
| | 100 | 1400 |

② Cap thickness, Dimension

③ Cap reinforcement

④ Pile design

# number of required piles

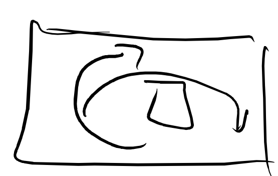
① case 1 : no moment

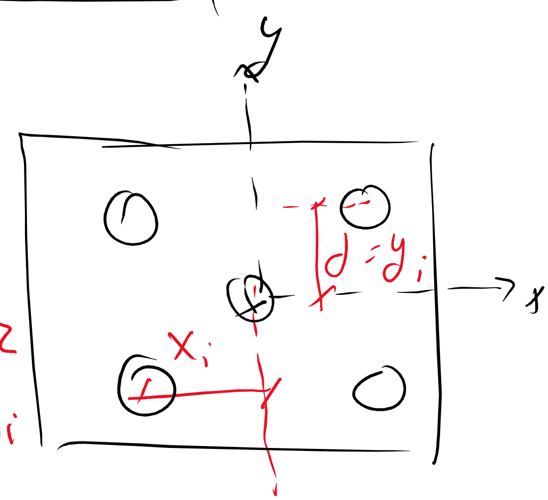
$$\#\text{Piles} = \frac{\text{total service load}}{\text{Pile Capacity}}$$

② with moment

$$\sigma_{max} = \frac{P}{A} + \frac{M_x C_x}{I_x} + \frac{M_y C_y}{I_y}$$

($C_x \rightarrow y_{max}$, $C_y \rightarrow x_{max}$.)






$$I_x = \sum I_{xi}$$

$$= \sum\left(I_{x0} + A_i d_i^2\right) = \sum A_i y_i^2$$

($I_{x0}$: small)

$$I_y = \sum A_i x_i^2$$

$$\sigma_{max} = \frac{P}{\sum A_i} + \frac{M_x\, y_{max}}{\sum A_i y_i^2} + \frac{M_y \times X_{max}}{\sum A_i x_i^2}$$

↳ if $A_i$ constant (in most cases)

$$A_i = A_p$$

$$\sigma_{max} = \frac{P}{N \times A_p} + \frac{M_x\, y_{max}}{A_p \sum y_i^2} + \frac{M_y \times X_{max}}{A_p \sum x_i^2}$$

↳ stress

→ Load

$R_{max}$ (reaction on Pile)

$$R_{max} = \sigma_{max} \times A_p = \left( \frac{P_s}{N} + \frac{M_x\, y_{max}}{\sum y_i^2} + \frac{M_y \times X_{max}}{\sum X_i^2} \right)$$

↓

for single pile.

$R_{max} < Q_{all}$

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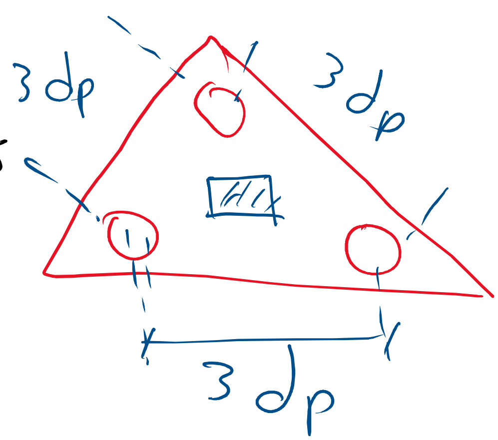
## Notes

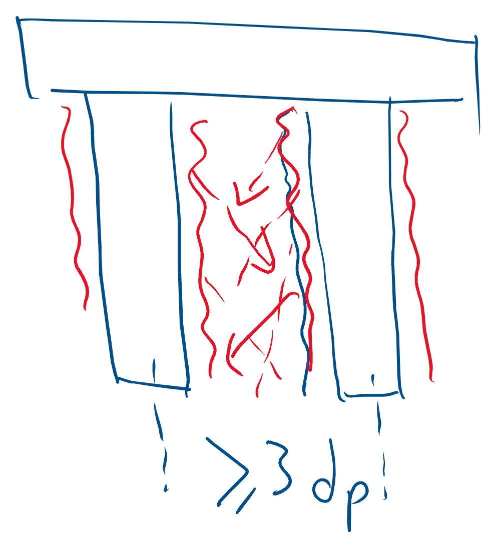
① Piles Center to Center placement $\geq 3\,d_p$

② $R_{max} = \dfrac{P}{N}$ if no moment on Column.

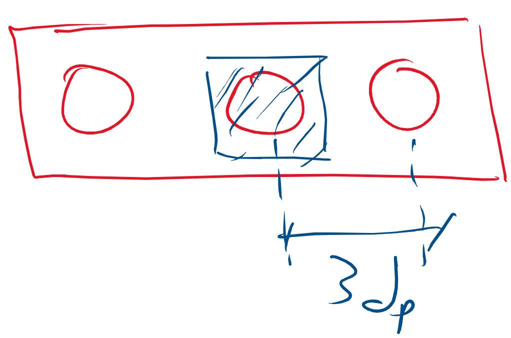
N ← عدد البايلز

③ 3 piles

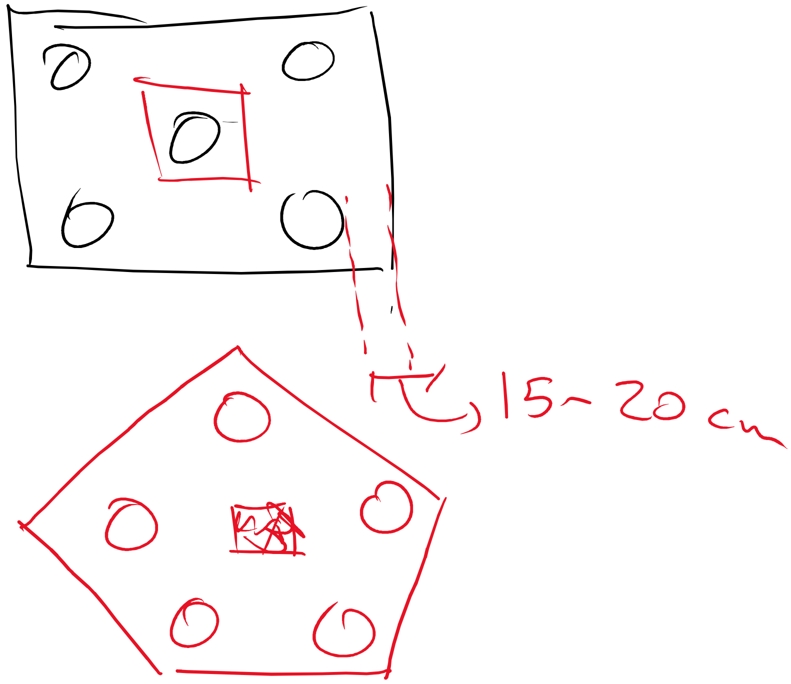



3 piles



## 5 pile




(4) incase of tension Load on Pile (from load or moment)

$$R_{min} = \frac{P}{N} - \frac{M_x\, y_{max}}{\sum y_i^2} - \frac{M_y\, x_{max}}{\sum x_i^2} \geq Q_{all} \text{ in tension}$$

→ Pile Capacity in Comprission $Q_{all_C}$

→ Pile Capacity in tension $Q_{all_T}$

## thickness (cap)

→ Punching Shear

→ Punching of Column on Cap

→ Punching of Pile on Cap

→ Column subjected to moment

Punching load

in Pile → $V_u = R_{max} \times N$

→ no moment on Column but eccentricity exist → normall Calculation.

→ Pile diamters → 50 cm, 60, 80, 100 cm

Eample Draw the pile Cap Showing all dimensions for pile footing supporting

$P_D = 5000$ kN   $M_D = 600$ kN.m in X

$P_L = 2500$ kN   $M_L = 300$ kN.m in X

$Q_{all} = 1500$ kN / Pile Diamter = 0.8 m

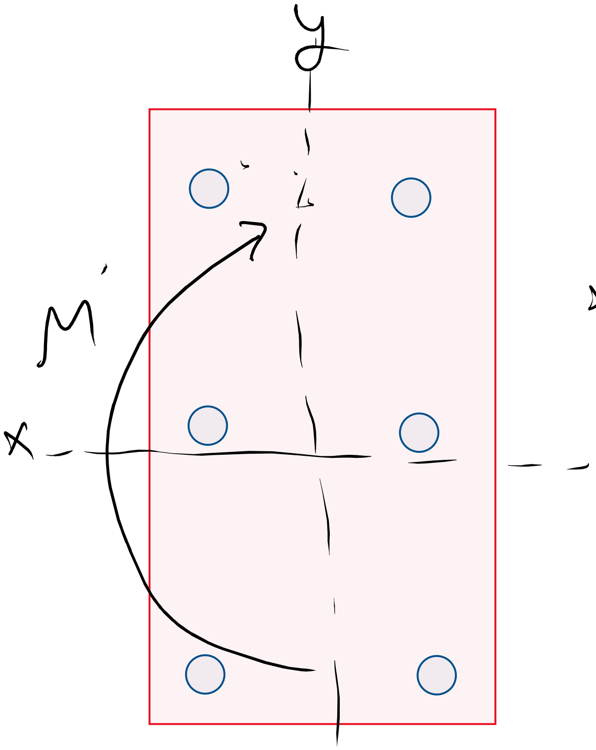
→ $P_{service} = 7500$ kN

$M_s = 9000$

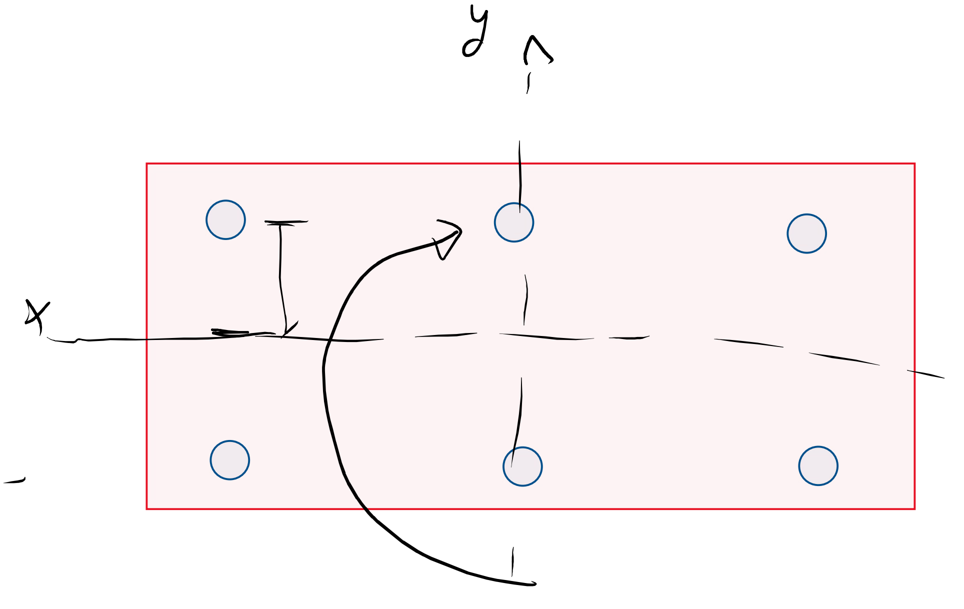
→ # of Pile

if no moment → $N = \frac{7500}{1500} = 5$

Because of moment try 6 Pile.




Case 1

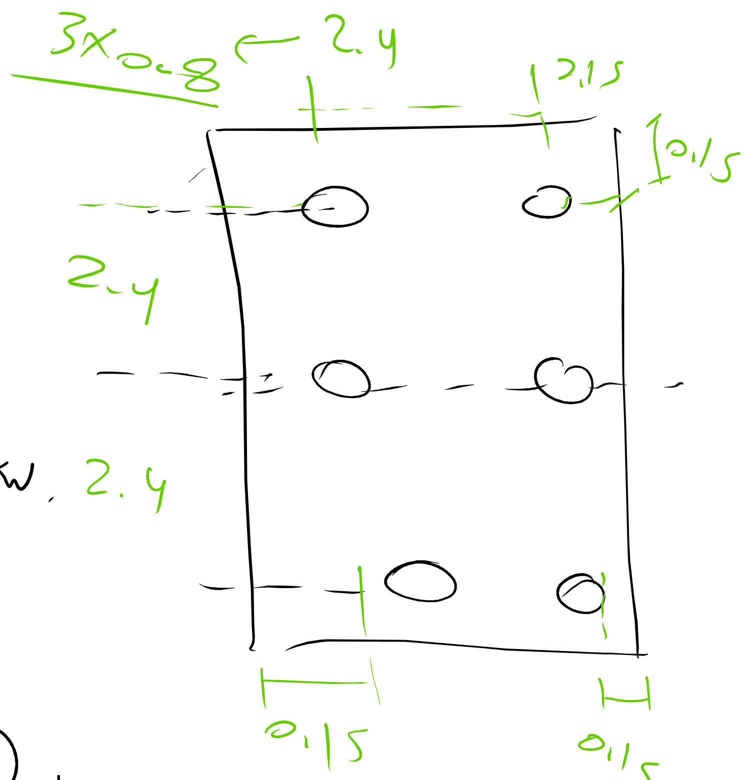



Case 2

arrangement 1 is the stronger.

$$R_{max} = \frac{7500}{6} + \frac{\overset{M_x}{900 \times 2.4}}{4 \times 2.4^2 + 2 \times 0^2}$$

$= 1344$ kN $< Q_{all} = 1500$ kN.




for Case 2 $R_{max} > Q_{all}$