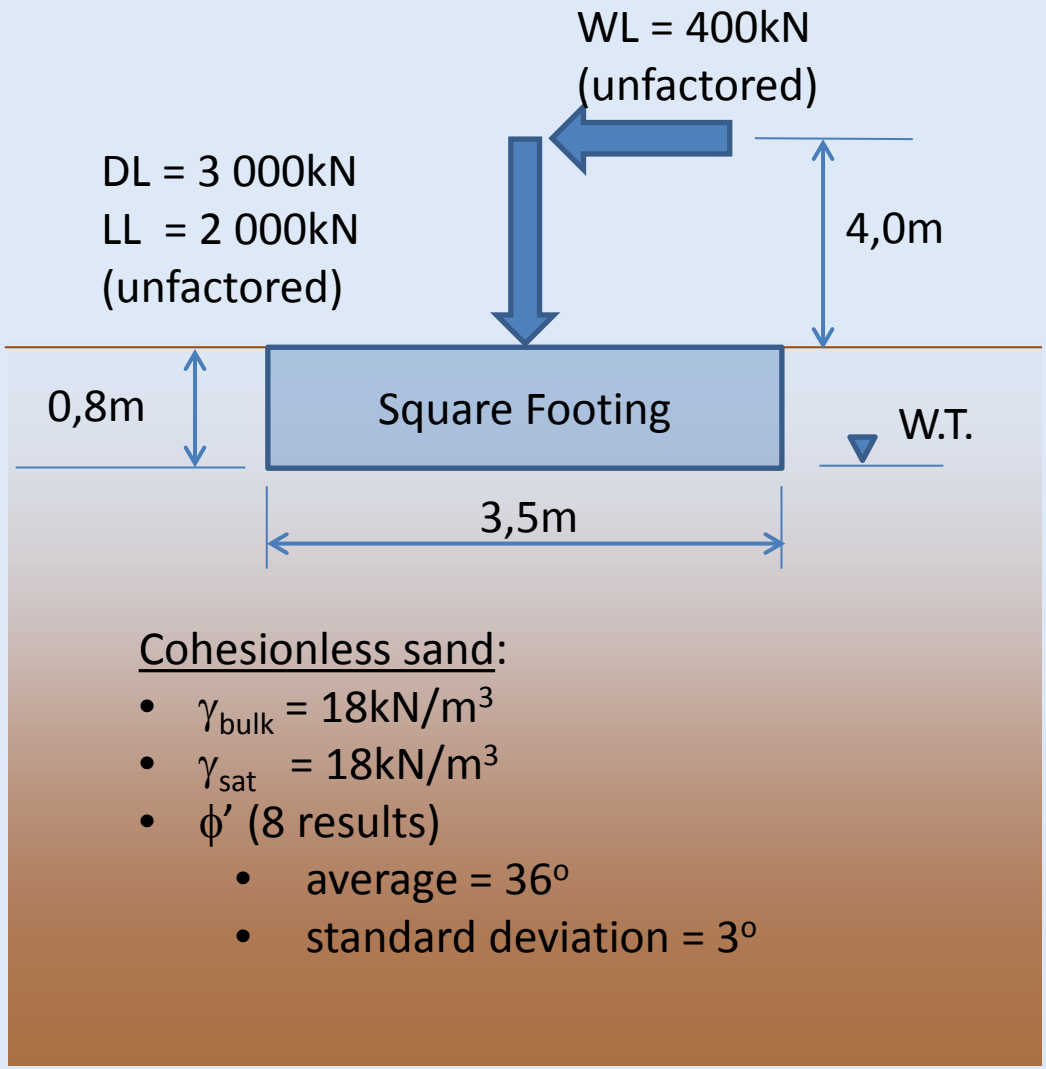
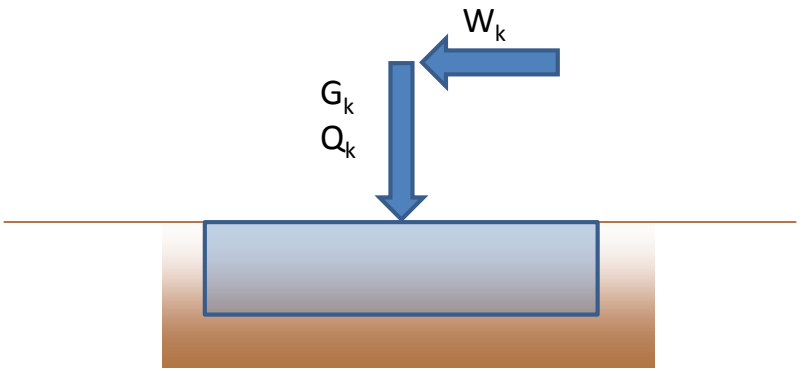
4b. Bearing Capacity, Cohesionless Sand -LSD



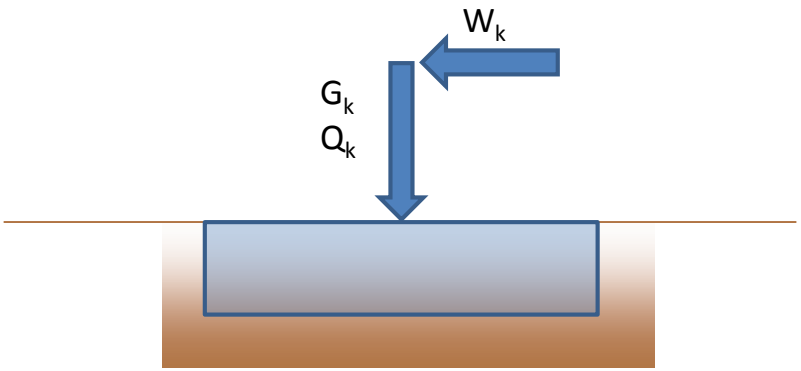
Determine whether design meets ultimate limit state design verification criteria



Actions

Questions:

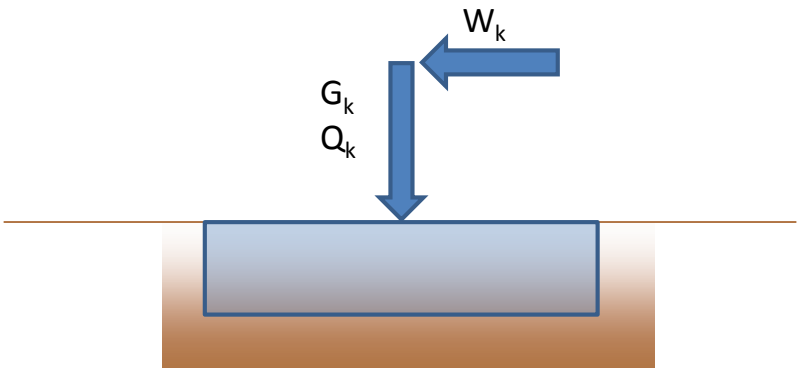
1. Are the live loads (G_k and Q_k) coupled?
2. Is the live load (Q_k) an always acting load?
3. Which is the leading variable action?



STR Limit State

$$\sum_{j\geq 1} \gamma_{G,j} \times G_{k,j} \quad "+" \quad \gamma_{Q,1} \times Q_{k,1} \quad "+" \quad \sum_{i>1} \gamma_{Q,i} \times \psi_i \times Q_{k,i}$$

	Permanent	Leading	Accompanying
V un-favourable			
W_k leading	1,2 . G_k	1,3 . W_k	1,6 . 0,3 . Q_k
Q_k leading	1,2 . G_k	1,6 . Q_k	1,3 . 0,0 . W_k
V favourable			
W_k leading	1,2 . G_k	1,3 . W_k	0,0 . 0,3 . Q_k
Q_k leading	1,2 . G_k	0,0 . Q_k	1,3 . 0,0 . W_k



STR Limit State

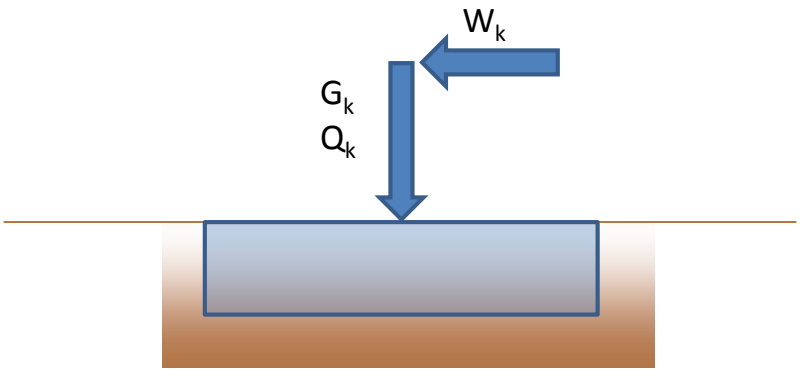
$$\sum_{j\geq 1} \gamma_{G,j} \times G_{k,j} \quad "+" \quad \gamma_{Q,1} \times Q_{k,1} \quad "+" \quad \sum_{i>1} \gamma_{Q,i} \times \psi_i \times Q_{k,i}$$

V un-favourable

W_k leading	1,2 . G_k	1,3 . W_k	1,6 . 0,3 . Q_k
Q_k leading	1,2 . G_k	1,6 . Q_k	1,3 . 0,0 . W_k

V favourable

W_k leading	1,2 . G_k	1,3 . W_k	0,0 . 0,3 . Q_k
Q_k leading	1,2 . G_k	0,0 . Q_k	1,3 . 0,0 . W_k



STR Limit State

$$\sum_{j\geq 1} \gamma_{G,j} \times G_{k,j} \quad "+" \quad \gamma_{Q,1} \times Q_{k,1} \quad "+" \quad \sum_{i>1} \gamma_{Q,i} \times \psi_i \times Q_{k,i}$$

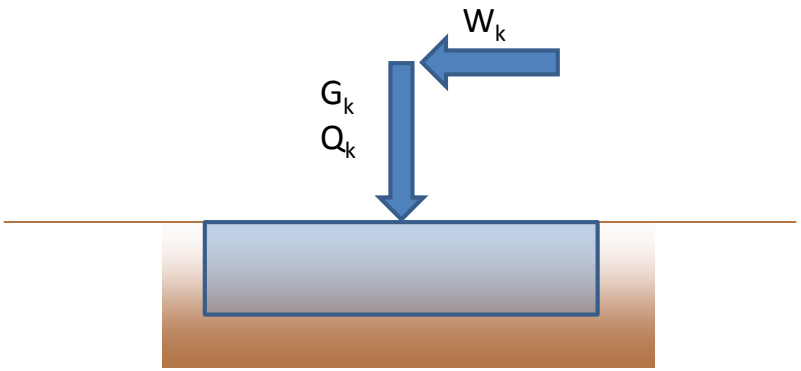
V un-favourable

W_k leading	1,2 . G_k	1,3 . W_k	1,6 . 0,3 . Q_k
Q_k leading	1,2 . G_k	1,6 . Q_k	

V favourable

W_k leading	1,2 . G_k	1,3 . W_k
Q_k leading	1,2 . G_k	

Not critical



STR Limit State

$$\sum_{j\geq 1} \gamma_{G,j} \times G_{k,j} \quad "+" \quad \gamma_{Q,1} \times Q_{k,1} \quad "+" \quad \sum_{i>1} \gamma_{Q,i} \times \psi_i \times Q_{k,i}$$

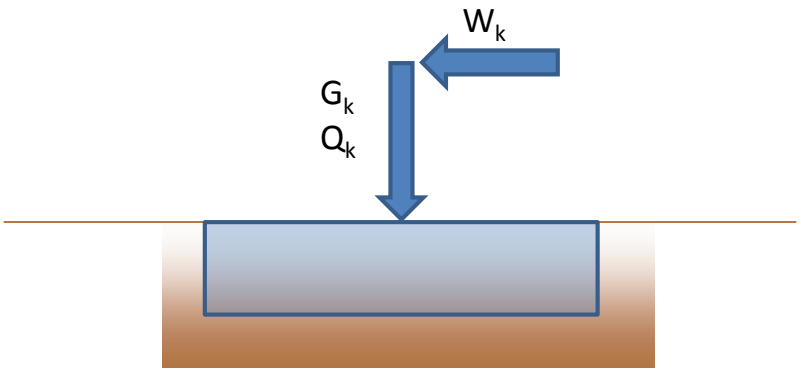
V un-favourable

W_k leading	1,2 . G_k	1,3 . W_k	1,6 . 0,3 . Q_k
Q_k leading	1,2 . G_k	1,6 . Q_k	

V favourable

W_k leading	1,2 . G_k	1,3 . W_k
Q_k leading	1,2 . G_k	

Not critical



STR Limit State

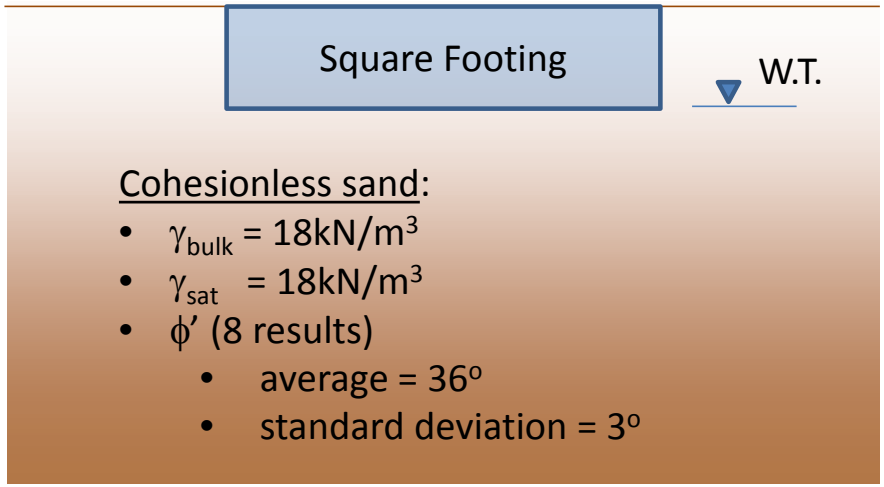
$$\sum_{j\geq 1} \gamma_{G,j} \times G_{k,j} \quad "+" \quad \gamma_{Q,1} \times Q_{k,1} \quad "+" \quad \sum_{i>1} \gamma_{Q,i} \times \psi_i \times Q_{k,i}$$

V un-favourable

W_k leading	1,2 . G_k	1,3 . W_k	1,6 . 0,3 . Q_k
Q_k leading	1,2 . G_k	1,6 . Q_k	

V favourable

W_k leading	1,2 . G_k	1,3 . W_k



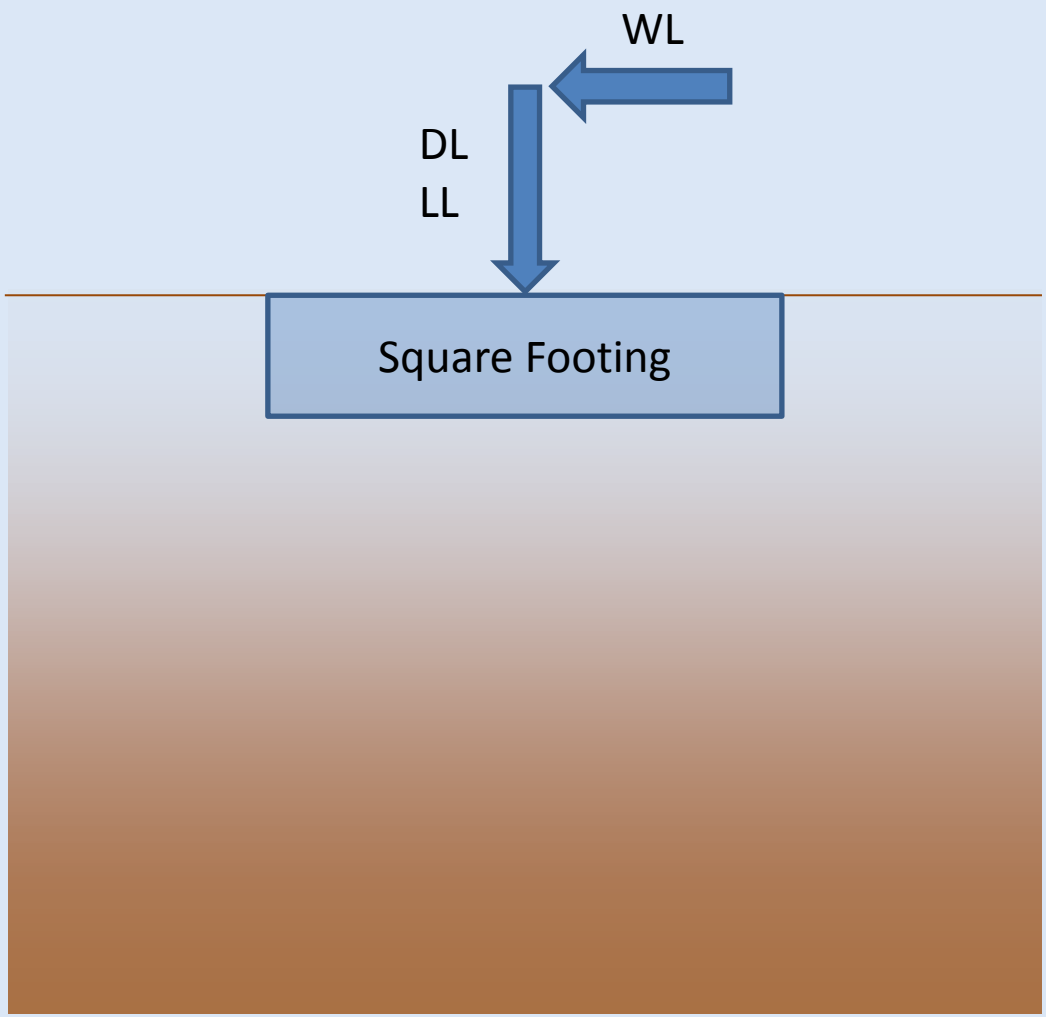
Resistances

Questions:

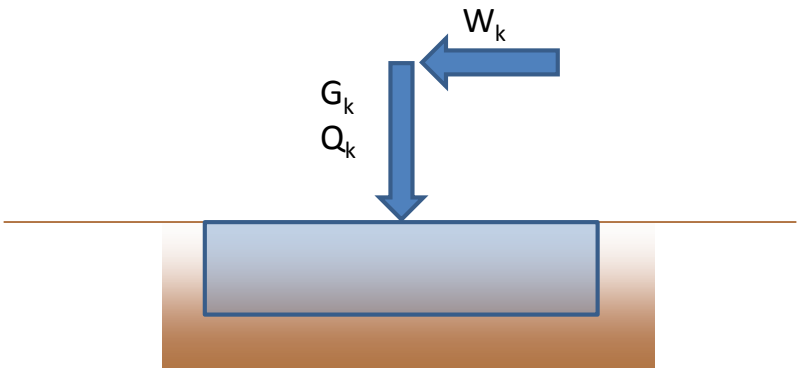
1. Characteristic value for ϕ'?
   - 5% fractile of individual results?
   - 5% fractile on mean value?
   - Cautious estimate?
2. Can the water table rise?
3. Footing geometry (size, embedment, etc)?

See Excel spreadsheet Soultion4b.xlsx

4c. Settlement -LSD



Determine load combinations to use for reversible and irreversible serviceability limit state



Serviceability Limit State

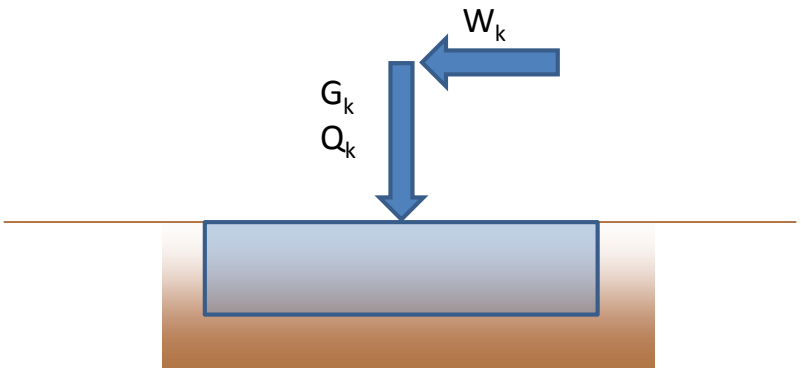
Irreversible $\sum_{j\geq 1} \gamma_{G,j} \times G_{k,j}$ "+" $\gamma_{Q,1} \times Q_{k,1}$ "+" $\sum_{i>1} \gamma_{Q,i} \times \psi_i \times Q_{k,i}$

W_k leading	1,1 . G_k	0,6 . W_k	1,0 . 0,3 . Q_k
Q_k leading	1,1 . G_k	1,0 . Q_k	

Reversible $\sum_{j\geq 1} \gamma_{G,j} \times G_{k,j}$ "+" $\sum_{i\geq 1} \psi_i \times Q_{k,i}$

W_k leading	1,1 . G_k	
Q_k leading	1,1 . G_k	1,0 . Q_k

Not critical



Serviceability Limit State

Irreversible

$$\sum_{j\geq 1} \gamma_{G,j} \times G_{k,j} \quad "+" \quad \gamma_{Q,1} \times Q_{k,1} \quad "+" \quad \sum_{i>1} \gamma_{Q,i} \times \psi_i \times Q_{k,i}$$

W_k leading	1,1 . G_k	0,6 . W_k	1,0 . 0,3 . Q_k
Q_k leading	1,1 . G_k	1,0 . Q_k	

Use for sands

Reversible

$$\sum_{j\geq 1} \gamma_{G,j} \times G_{k,j} \quad "+" \quad \sum_{i\geq 1} \psi_i \times Q_{k,i}$$

Q_k leading	1,1 . G_k	1,0 . Q_k

Use for clays