

**SHEAR CAPACITY OF CENTRUM PILES**  
**DESIGN IN ACCORDANCE WITH EC 2**

***Design Parameters***

Pile	Pile depth		$h := 400 \cdot \text{mm}$
	Pile width		$b_w := 400 \cdot \text{mm}$
	cover		$c_b := 30 \cdot \text{mm}$
Tension (Bottom) Reinforcement			
	Number of bars (mimimum)	$n_b := 4$	Bar diameters $\phi_b := 12 \cdot \text{mm}$
Shear Links			
	Number of legs	$n_v := 2$	Link diameter $\phi_v := 5 \cdot \text{mm}$
	Spacing of links	$s_v := 120 \cdot \text{mm}$	

***Material Parameters***

concrete characteristic cylinder strength		$f_{ck} := 50 \cdot \frac{\text{N}}{\text{mm}^2}$
steel reinforcement characteristic strength		$f_{yk} := 500 \cdot \frac{\text{N}}{\text{mm}^2}$
shear steel reinforcement characteristic strength		$f_{ywk} := 500 \cdot \frac{\text{N}}{\text{mm}^2}$
Rebar Modulus		$E := 200000 \cdot \frac{\text{N}}{\text{mm}^2}$

Table 2.1N partial factors for materials at the ultimate limit state

EN 13369:2004 C.2 modified material factors	steel	$\gamma_s := 1.10$
	concrete	$\gamma_c := 1.40$

Effective depth

$$d_b := h - c_b - \frac{\phi_b}{2}$$

$$d_b = 364 \cdot \text{mm}$$

Main Rebar Area

$$A_{s_b} := n_b \cdot \pi \cdot \frac{\phi_b^2}{4}$$

$$A_{s_b} = 452.4 \cdot \text{mm}^2$$

Shear Rebar Area

$$A_{s_w} := n_v \cdot \pi \cdot \frac{\phi_v^2}{4}$$

$$A_{s_w} = 39.3 \cdot \text{mm}^2$$

nominal lever arm value

$$z := 0.9 \cdot d_b$$

for non-prestressed structures

$$\alpha_{cw} := 1$$

6.6 N

$$v_1 := 0.6 \cdot \left( 1 - \frac{f_{ck}}{250 \cdot \frac{N}{\text{mm}^2}} \right)$$

$$v_1 = 0.5$$

angle between shear reinforcement and member axis

$$\alpha := 90 \cdot \text{deg}$$

$$f_{cd} := \frac{f_{ck}}{\gamma_c}$$

$$f_{cd} = 35.7 \cdot \frac{N}{\text{mm}^2}$$

$$\theta_{\min} := \text{acot}(2.5)$$

$$\theta_{\min} = 21.8 \cdot \text{deg}$$

Concrete Capacity

$$V_{Rd.min.22} := \frac{\alpha_{cw} \cdot b_w \cdot z \cdot v_1 \cdot f_{cd}}{(\cot(\theta_{min}) + \tan(\theta_{min}))} \quad V_{Rd.min.22} = 774.6 \cdot kN$$

Shear link Capacity

$$V_{Rd.s1} := \frac{A_{sw}}{s_v} \cdot z \cdot \frac{f_{ywk}}{\gamma_s} \cdot \cot(\theta_{min}) \quad V_{Rd.s1} = 121.8 \cdot kN$$

Shear Capacity

$$V_{Rd} := \min(V_{Rd.min.22}, V_{Rd.s1}) \quad V_{Rd} = 121.8 \cdot kN$$

Additional longitudinal bars

$$\Delta F_{td1} := 0.5 \cdot V_{Rd} \cdot (\cot(\theta_{min}) - \cot(\alpha)) \quad \Delta F_{td1} = 152.3 \cdot kN$$

$$A_{s_{td1}} := \frac{\Delta F_{td1}}{\frac{f_{yk}}{\gamma_s}} \quad A_{s_{td1}} = 335 \cdot mm^2$$

$$\text{Area of main reinforcement} \quad A_{s_b} = 452.4 \cdot mm^2$$

Additional reinforcement needs to be at least equal to area of reinforcement provided

Additional\_reinforcement = "satisfactory"