$$Calculation headline$$

**Cross section parameters**



**Concrete parameters**

$$Concrete$$

$$C 25/30$$

$$Char. compressive strength$$

$$= f\_{ck }25 MPa$$

$$Modulus of elasticity$$

$$= E\_{cm }31 GPa$$

$$Concrete compressive strength$$

$$f\_{cd}=\frac{α\_{cc}∙f\_{ck}}{γ\_{c}}=\frac{1∙25}{1.5}=16.7 MPa$$

$$Tensile strength of concrete$$

$$f\_{ctd}=\frac{α\_{cc}∙f\_{ctk,0,05}}{γ\_{c}}=\frac{1∙1.8}{1.5}=1.2 MPa$$

$$Compressive strain of concrete$$

$$ε\_{cd}=\frac{f\_{cd}}{E\_{cm}}=\frac{16.7}{31}= 538∙10^{-6}$$

$$Concrete coefficients$$

$$= α\_{cc }1$$

$$η=1 $$

$$λ=0.8 $$

$$ <= 50MPa)(f\_{ck}$$

$$Coefficient of shear strength$$

$$ = ν\_{1}0.6$$

$$Coeff. of strain in tension strip$$

$$ = α\_{cw}1$$

**Reinforcement parameters**

$$Reinforcement$$

$$B 500 A$$

$$Characteristic tensile strength$$

$$ = f\_{yk}500∙10^{6}$$

$$Design tensile strength$$

$$f\_{yd}=\frac{f\_{yk}}{γ\_{S}}=\frac{500∙10^{6}}{1.15}= 435∙10^{6}$$

$$Compressive strain$$

$$ε\_{yd}=\frac{f\_{yd}}{E\_{s}}=\frac{435∙10^{6}}{200∙10^{9}}= 2.17∙10^{-3}$$

$$Maximum compressive strain$$

$$Unlimited$$

**Table of combinations of internal forces**

|  |  |  |  |
| --- | --- | --- | --- |
| **#** | **N [kN]** | **Vy [kN]** | **UC** |
| 1 | 50 | 102 | 0.403 |
| 2 | 0 | 50 | 0.198 |
| 3 | 12 | 37 | 0.146 |
| 4 | 106 | 115 | 0.454 |
| 5 | 17 | 86 | 0.34 |

$$Extreme is produced by combination: 4$$

$$Check shear reinforcement for extreme combination$$

**Load**

$$Cross section axial stress$$

$$σ\_{cp}=\frac{N\_{Ed}}{A\_{c}}=\frac{106000}{0.165}=0.642 MPa$$

$$Coefficient of strain in compr. chord$$

$$α\_{cw}=1+\frac{σ\_{cp}}{f\_{cd}}=1+\frac{642424}{16.7∙10^{6}}=1.04 $$

$$Cotangent of compressed angle$$

$$cot=cotg\left(45\right)=1 $$

**Coefficient of shear bearing capacity**

$$Coefficient of shear strength (without stirrups)$$

$$C\_{Rdc}=\frac{0.18}{γ\_{c}}=\frac{0.18}{1.5}=0.12 $$

$$Coefficient of shear strength$$

$$k\_{1}=0.15 $$

$$Coefficient of minimum value of shear resistance of the member without shear reinforcement$$

$$v\_{min}=0.035∙k^{\frac{3}{2}}∙f\_{ck}^{\frac{1}{2}}=0.035∙1.61^{\frac{3}{2}}∙25^{\frac{1}{2}}=0.358 $$

**Bearing capacity of concrete**

$$Bearing capacity without shear reinforcement$$

$$V\_{Rd,cc}\begin{matrix}=\left(C\_{Rdc}∙k∙\left(100∙ρ\_{1}∙f\_{ck}\right)^{\frac{1}{3}}+k\_{1}∙σ\_{cp}\right)∙\left(b∙d\right)∙10^{6}\\=\left(0.12∙1.61∙\left(100∙3.06∙10^{-3}∙25\right)^{\frac{1}{3}}+0.15∙0.642\right)∙\left(0.25∙0.537\right)∙10^{6}=64 kN\end{matrix}$$

$$Minimum bearing capacity of concrete$$

$$V\_{Rd,c,min}=\left(v\_{min}+k\_{1}∙σ\_{cp}\right)∙\left(b∙d\right)∙10^{6}=\left(0.358+0.15∙0.642\right)∙\left(0.25∙0.537\right)∙10^{6}=60.9 kN$$

$$V\_{Rd,c}=max\left(V\_{Rd,cc}; V\_{Rd,c,min}\right)=max\left(64; 60.9\right)=64 kN$$

**Bearing capacity of vertical stirrups**

$$Bearing capacity of stirrups$$

$$V\_{Rd,sw}=\frac{A\_{sw}}{s\_{w}}∙z∙f\_{ywd}∙cotg\left(θ\right)=\frac{101∙10^{-6}}{0.15}∙0.483∙400∙10^{6}∙cotg\left(45\right)=129 kN$$

$$Max. bearing capacity of vertical stirrups$$

$$V\_{Rd,sw,max}=\frac{α\_{cw}∙b∙z∙ν\_{1}∙f\_{cd}}{cotg\left(θ\right)+tg\left(θ\right)}=\frac{1.04∙0.25∙0.483∙0.6∙16.7∙10^{6}}{cotg\left(45\right)+tg\left(45\right)}=627 kN$$

$$V\_{Rd,sw}=min\left(V\_{Rd,sw}; V\_{Rd,sw,max}\right)=min\left(129479; 626999\right)=129 kN$$

**Bearing capacity of angled bends**

$$Bearing capacity of angled bends$$

$$V\_{Rd,sb}\begin{matrix}=\frac{A\_{sb}}{s\_{b}}∙z∙f\_{ybd}∙\left(cotg\left(θ\right)+cotg\left(α\right)\right)∙sin\left(α\right)\\=\frac{226∙10^{-6}}{0.5}∙0.483∙400∙10^{6}∙\left(cotg\left(45\right)+cotg\left(45\right)\right)∙sin\left(45\right)=124 kN\end{matrix}$$

$$Maximal bearing capacity of angled bends$$

$$V\_{Rd,sb,max}\begin{matrix}=\frac{α\_{cw}∙b∙z∙ν\_{1}∙f\_{cd}∙\left(cotg\left(θ\right)+cotg\left(α\right)\right)}{1+\left(cotg\left(θ\right)\right)^{2}}\\=\frac{1.04∙0.25∙0.483∙0.6∙16.7∙10^{6}∙\left(cotg\left(45\right)+cotg\left(45\right)\right)}{1+\left(cotg\left(45\right)\right)^{2}}=1254 kN\end{matrix}$$

$$V\_{Rd,sb}=min\left(V\_{Rd,sb}; V\_{Rd,sb,max}\right)=min\left(124; 1254\right)=124 kN$$

**Bearing capacity of cross section**

$$V\_{Rd}=Min\left\{\begin{matrix}V\_{Rd,sw}+V\_{Rd,sb}\\V\_{Rd,sw,max}\\V\_{Rd,sb,max}\end{matrix}\right\}=Min\left\{\begin{matrix}129+124\\627\\1254\end{matrix}\right\}=253 kN$$

**Check**

$$s=\frac{V\_{Ed}}{V\_{Rd}}=\frac{115 kN}{253 kN}=0.454 $$

$$< 1 => Bearing capacity is SUFFICIENT$$

