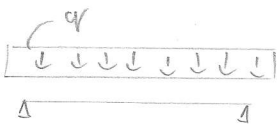
$l = 2625$ mm

$l_{eb} = 2825$ mm

$a = 100$ mm

$b = 1000$ mm

$d = 170$ mm



Vrstva	Char. zatížení	x C	K_{Fi}	návrhové zat.
Dažba 27 mm	23 x 0,027	1,35	0,9	0,755
MVC 0,3 mm	21 x 0,003	1,35	0,9	0,077
tep. mazanina 50 mm	23 x 0,05	1,35	0,9	1,397
hydroizolace 3 mm	0,45 x 0,003	1,35	0,9	0,0016
ŽB deska 170 mm	25 x 0,17	1,35	0,9	3,944
Omítka	20 x 0,02	1,35	0,9	0,486
Stálé	$\Sigma = 5,485$ kN	1,35	0,9	6,665
nahodilé	4,0 kN	1,5	0,9	5,400
Celkem	9,0485			12,065

Stálé návrhové zatížení $g_d = 6,665$ kN/m

nahodilé návrhové zatížení $q_d = 5,4$ kN/m

STATICKÉ VELIČINY

$$M_{Ed,g} = \frac{1}{8} g_d \cdot l_{ef}^2 = \frac{1}{8} 6,665 \cdot 2,825^2 = 6,649 \text{ kN/m}$$

$$M_{Ed,q} = \frac{1}{8} q_d \cdot l_{ef}^2 = \frac{1}{8} \cdot 5,4 \cdot 2,825^2 = 5,387 \text{ kN/m}$$

$$M_{Ed} = M_{Ed,g} + M_{Ed,q} = 6,649 + 5,387 = 12,036 \text{ kN/m}$$

$$V_{Gd} = \frac{1}{2} g \cdot d \cdot l_{ef} = \frac{1}{2} \cdot 6,665 \cdot 2,825 = 9,414 \text{ kN/m}$$

$$V_{Qd} = \frac{1}{2} q \cdot d \cdot l_{ef} = \frac{1}{2} \cdot 5,4 \cdot 2,825 = 7,628 \text{ kN/m}$$

$$V_{Ed} = V_{Gd} + V_{Qd} = 9,414 + 7,628 = 17,042 \text{ kN/m}$$

DIMENZOVÁNÍ

Beton C 25/30

$f_{cd} = f_{ck} / \gamma_c = 25 / 1,5 = 16,67$ MPa

$f_{ctm} = 2,6$ MPa

$\gamma_c = 1,5$

$\varepsilon_{c3} = 0,175\ ‰$

$\varepsilon_{cu3} = 0,35\ ‰$

Ocelová výztuž B 410 - 10 425 (V)

$f_{yd} = f_{yk} / \gamma_s = 410 / 1,15 = 356,52$ MPa

$\gamma_s = 1,15$ dal

$E_s = 200$ GPa

$\varepsilon_{yd} = f_{yd} / E_s = 356,52 / 200 \cdot 10^3 \cdot 100\ ‰ = 0,18\ ‰$

KRYTÍ

$c_{nom} = c_{min} + \Delta c_{dev}$

Stupeň vlivu prostředí XO

Konstrukční třída pro desku - 3

Odhadovaný průměr výztuže $\phi_s = \left(\frac{1}{12} - \frac{1}{10}\right) \cdot h =$

$\phi_{s1} = \frac{1}{10} \cdot 130 = 13$ mm

$\phi_{s2} = \frac{1}{12} \cdot 130 = 10,8$ mm

navrhuju 12 mm

(12, 10, 10)

$c_{min} \geq \phi \Rightarrow \geq 12$ mm navrhuji 12 mm $\Delta c_{dev} = 10$ mm

$c_{nom} = c_{min} + \Delta c_{dev} = 12 + 10 = 24$ mm

$c_d = 25$ mm

D1

$d = h - c_d - \phi_s/2 = 170 - 25 - \frac{12}{2} = 99\ mm$

$d_1 = h - d = 170 - 99 = 41\ mm$

NÁVRH VÝZTUŽE

$$A_{s0} = b \cdot d \cdot (f_{cd}/f_{yd}) \cdot \left(1 - \sqrt{1 - \frac{2 \cdot M_{Ed}}{b \cdot d^2 \cdot f_{cd}}}\right) =$$

$$= 1 \cdot 0{,}094 \cdot \frac{16{,}67}{356{,}52} \cdot \left(1 - \sqrt{1 - \frac{2 \cdot 10{,}203}{1 \cdot 0{,}099^2 \cdot 16670}}\right) = 3{,}012 \cdot 10^{-4}\ m^2$$

$A_s = \pi \cdot \frac{d^2}{4} \cdot (1000/200) = \pi \cdot \frac{12^2}{4} \cdot 5 = 565{,}5\ mm^2$

$\phi 12$ na ~~na~~ 240 $\Rightarrow$ 200 $A_{s1} = 3{,}90 \cdot 10^{-4}\ m^2$

$A_{s\,min} = 0{,}26 (f_{ctm}/f_{yk}) \cdot b \cdot d = 0{,}26 \frac{2{,}6}{410} \cdot 1 \cdot 0{,}094 = 1{,}55 \cdot 10^{-11}\ m^2$

$A_{s\,max} = 0{,}4 \cdot A_c = 0{,}04 \cdot b \cdot d = 0{,}04 \cdot 1 \cdot 0{,}094 = 3{,}76 \cdot 10^{-3}\ m^2$

OSVĚDČENÍ VZÁJEMNÉ VZDÁLENOSTI PRUTŮ

$s_{max} \leq 2 \cdot h = 2 \cdot 170 = 260$

$s_{min} = 65\ mm$

$x = (A_{s1} \cdot f_{yd}) / (b \cdot \lambda \cdot f_{cd}) =$

$(3{,}90 \cdot 10^{-4} \cdot 356{,}52) / (1{,}0 \cdot 0{,}8 \cdot 16{,}67) = 0{,}0104\ m$

$z_c = d - x \cdot \lambda/2 = 0{,}099 - 0{,}0104 \cdot 0{,}8/2 = 0{,}0948\ m$

$M_{Rd} = A_{s1} \cdot f_{yd} \cdot z_c = (3{,}90 \cdot 10^{-4}) \cdot 356{,}52 \cdot 10^3 \cdot 0{,}0948 = 13{,}181\ kNm$

$M_{Rd} > M_{Ed} \rightarrow 13{,}18 > 12{,}005$

$x < \xi_{lim} \cdot d = 0{,}663 \cdot 99$

$\xi_{lim} = \frac{700}{700 + f_{yd}} = \frac{700}{700 + 356{,}52} = 0{,}663$

ROZDĚLOVACÍ VÝZTUŽ D1

$A_{SR_0} \geq 0,2\ A_{S1}$

$0,2 \cdot 3,1 \cdot 10^{-4} = 7,8 \cdot 10^{-5}$

návrh $A_{SR} = 7,9 \cdot 10^{-5}\ m^2$

ϕ KARI 5 mm 250 mm

$s_{max} \leq 3 \cdot h \rightarrow \quad 250 \leq 360$

$s_{min} = 20\ mm$

vzorkování ale s čímkou dvojkolem $A_{S0} \cdot 0,25$

DÉLKA KOTEVNÍ VÝZTUŽE

$\sigma_{sd} = \frac{A_{S0}}{A_{S1}} \cdot f_{yd} = \frac{1,012 \cdot 10^{-4}}{1,90 \cdot 10^{-4}} \cdot 356,52 = 275,34\ MPa$

$f_{bd} = 2,25 \cdot \eta_1 \cdot \eta_2 \cdot f_{ctd} = 2,25 \cdot 1 \cdot 1 \cdot 1,2 = 2,7\ MPa$

$f_{ctd} = f_{ctk} / \gamma_M = \frac{1,8}{1,5} = 1,2$

$\alpha_1 = 1$

$\alpha_2 = 1 - 0,15 \cdot (c_d - \phi) / \phi = 1 - 15 \cdot (25 - 10)/10 = 1$

$\alpha_3 = 1 - K \cdot \lambda = 1 - 0,1 \cdot 0,416 = 0,9584$

$\lambda = (\Sigma A_{S1} - \Sigma A_{S1\,min}) / A_S = (1,90 \cdot 10^{-4} - 1,55 \cdot 10^{-4}) / 560,25 \cdot 10^{-6} =$

$= 0,416$

$\alpha_4 = 1$

$\alpha_5 = 1$

$f_{bnyd} = \frac{\phi}{4} \cdot \frac{\sigma_{sd}}{f_{bd}} = \frac{10}{4} \cdot \frac{275,34}{2,7} = 254,94\ mm$

$l_{bd} = \alpha_1 \cdot \alpha_2 \cdot \alpha_3 \cdot \alpha_4 \cdot \alpha_5 \cdot f_{bnyd} \geq l_{b\,min}$

$l_{bd} = 1 \cdot 1 \cdot 0,9643 \cdot 1 \cdot 1 \cdot 254,94 = 245,84\ mm$

$l_{b\,min} = \max(0,1 \cdot l_{b,nyd};\ 10 \cdot \phi;\ 100\ mm)$

$(67,66 \quad ; \quad 100 \quad ; \quad 100) = 100\ mm$

$l_{bd} = 245,84 \geq 100 = l_{b\,min}$

POSOUZENÍ NA SMYK D1

$b_w = 1000\ mm$

$d = 99\ mm$

$$C_{Rd,c} = \frac{0{,}18}{\gamma_M} = \frac{0{,}18}{1{,}5} = 0{,}12$$

$$k = 1 + \left(\frac{200}{99}\right)^{\frac{1}{2}} \leq 2$$

$$2{,}42 \not\leq 2$$

$$\downarrow$$

$$k = 2$$

$$\rho_l = \frac{A_{sl}}{b_w \cdot d} = \frac{3{,}9 \cdot 10^{-4}}{1 \cdot 0{,}099} = 0{,}0039\,39$$

$f_{ck} = 25\ MPa$

$$v_{min} = 0{,}035 \cdot k^{\frac{3}{2}} \cdot f_{ck}^{\frac{1}{2}} = 0{,}035 \cdot 2^{\frac{3}{2}} \cdot 25^{\frac{1}{2}} = 0{,}494\ kN$$

$$V_{Rdc} = C_{Rd,c} \cdot k (100 \cdot \rho_l \cdot f_{ck})^{\frac{1}{3}} \cdot b_w \cdot d$$

$$= 0{,}12 \cdot 2 (100 \cdot 0{,}003939 \cdot 25)^{\frac{1}{3}} \cdot 1000 \cdot 99 = 50{,}93\ kN$$

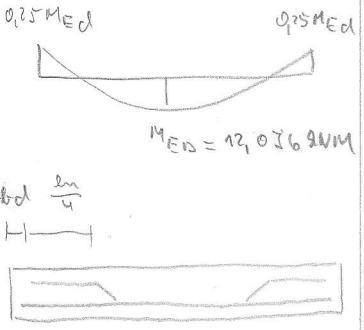
$$v_{min} \cdot b_w \cdot d = 0{,}494 \cdot 1000 \cdot 99 = 48{,}99\ kN$$

$$V_{Rdc} > v_{min} \cdot b_w \cdot d$$

$$50{,}93 > 48{,}99$$

vyhovuje smykem

HORNÍ VÝZTUŽ V DESCE D1



dolní výztuž : $A_{s1} = 3{,}90 \cdot 10^{-4}\ m$ .... $\phi 12$

horní výztuž : $A_{s2d} = 0{,}25 \cdot A_{s1} = 0{,}975 \cdot 10^{-4}\ m$

$\Rightarrow A_{s2} = 1{,}54 \cdot 10^{-4}\ m$ $4 \times \phi 7$

$$\sigma_{sd} = \frac{A_{s2d}}{A_{s2}} \cdot f_{yd} = \frac{0{,}975 \cdot 10^{-4}}{1{,}54 \cdot 10^{-4}} \cdot 356{,}52 = 225{,}719\ MPa$$

$$f_{cbd} = \frac{f_{ck}}{\gamma_M} = \frac{1{,}8}{1{,}5} 1{,}2\ MPa$$

$$f_{bd} = 2{,}25 \cdot \eta_1 \cdot \eta_2 \cdot f_{cbd} = 2{,}25 \cdot 1 \cdot 1 \cdot 1{,}2 = 2{,}7\ MPa$$

$$l_{b,rqd} = \frac{\phi}{4} \cdot \frac{\sigma_{sd}}{f_{bd}} = \frac{7}{4} \cdot \frac{225{,}719}{2{,}7} = 146{,}20\ mm$$

$\alpha_1 = 1$

$\alpha_2 = 1 - 0{,}15 \cdot (c_d - 3 \cdot \phi)/\phi = 1 - 0{,}15 \cdot (25 - 3 \cdot 7)/7 = 0{,}9147$

$\alpha_3 = 1 - \eta \cdot \lambda = 1 - 0{,}05 \cdot 1{,}583 = 0{,}92$

$$\lambda = \frac{1{,}54 \cdot 10^{-4}}{0{,}973 \cdot 10^{-4}} = 1{,}583$$

$\alpha_4 = 1$

$\alpha_5 = 1$

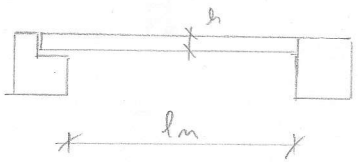
$l_{bd} = \alpha_1 \cdot \alpha_2 \cdot \alpha_3 \cdot \alpha_4 \cdot \alpha_5 \cdot l_{b,rqd} \geq l_{b,min}$

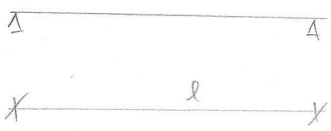
$l_{bd} = 1 \cdot 0{,}9147 \cdot 0{,}92 \cdot 1 \cdot 1 \cdot 146{,}20 = 122{,}977\ mm$

$l_{b\,min} = \max(0{,}3 \cdot l_{b,rqd}\ ;\ 10 \cdot \phi\ ;\ 100)$

$= \max(43{,}86\ ;\ 70\ ;\ 100)$

$l_{bd} > l_{b\,min}$





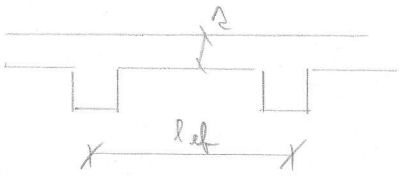
D_1: $h = \frac{1}{12} l = \frac{1}{20} 2625 = 131 \div 170$ mm

$a_{min} = \left(\frac{h}{2} ; \frac{d}{2} \right) = \frac{170}{2} ; \frac{450}{2} = 65$ mm $\Rightarrow 100$ mm

$l_{ef} = l_n + a_1 + a_2 = 2625 + 200 = 2825$

D_2: $h = \frac{1}{30} l = \frac{1}{30} \cdot 2100 = 70 \Rightarrow 80$

$a_{min} = \left(\frac{h}{2} ; \frac{d}{2} \right) = 35$

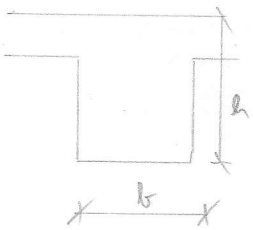


T_1: $h = \frac{1}{12} l = \frac{1}{12} 5375 = 448 \div 450$

$a_{min} = \left(\frac{h}{2} ; \frac{d}{2} \right) = \frac{520}{2} ; \frac{450}{2} = 225$

$l_{ef} = 5375 + 450 + 1500 + 225 = 7550$

$b = 0{,}6 \cdot h = 0{,}6 \cdot 520 = 312 \div 320$



P_1: $h = \frac{1}{10} l = \frac{1}{10} 4200 = 420 \Rightarrow 470$

$a_{min} = \frac{h}{2} = \frac{470}{2} = 235$

$l_{ef} = l_n + a_1 + a_2 = 4200 + 2 \cdot 235 = 4670$