

## STATICKÝ MODEL - GEOMETRIE :

$$l_x = 7550 \text{ mm}$$

$$l_y = 9300 \text{ mm}$$

$$h = \frac{1}{75} \cdot (l_x + l_y) = \frac{1}{75} \cdot (7,5 + 9,3) = 0,224 \text{ m} \rightarrow 0,24 \text{ m}$$

$$a_1 = \min \left\{ \frac{h}{2}, \frac{l}{2} \right\} = \min \left\{ \frac{0,24}{2}, \frac{0,30}{2} \right\} = \min \{0,12; 0,15\}$$

$$a_1 = 0,12 \text{ m}$$

$$a_2 = \min \left\{ \frac{h}{2}, \frac{l}{2} \right\} = \min \left\{ \frac{0,24}{2}, \frac{0,30}{2} \right\} = \min \{0,12; 0,15\} = 0,12 \text{ m}$$

$$a_1 = a_2 = a_3 = a_4 = 0,12 \text{ m}$$

$$l_{ef,x} = l_x + a_1 + a_2 = 7,55 + 0,12 + 0,12 = 7,79 \text{ m}$$

$$l_{ef,y} = l_y + a_3 + a_4 = 9,30 + 0,12 + 0,12 = 9,54 \text{ m}$$

## ZATÍŽENÍ :

VRSTVA	TL [m]	OBJ. HM. [kg/m³]	ZATEŽ. SÍLKA [m]	SOUČET [kN/m²]
DLAŽBA	0,09	20	1,0	0,18
BET. MAZANINA	0,05	22	1,0	1,1
ZVUKOVÁ IZOLACE	0,04	0,2	1,0	0,008
ŽB DESKA - VL.TIHA	0,24	25	1,0	6,0
SDK PODHLED	0,125	11	1,0	0,1375

$$\Sigma g_k = 7,43 \text{ kN/m}^2$$

$$q_k = 1,5 \text{ kN/m}^2$$

## KOMBINACE

$$6.10 \text{ a)} \quad 1,35 \cdot g_k + 1,5 \cdot 0,7 \cdot q_k = 1,35 \cdot 7,43 + 1,5 \cdot 0,7 \cdot 1,5 = 11,61 \text{ kN/m}^2$$

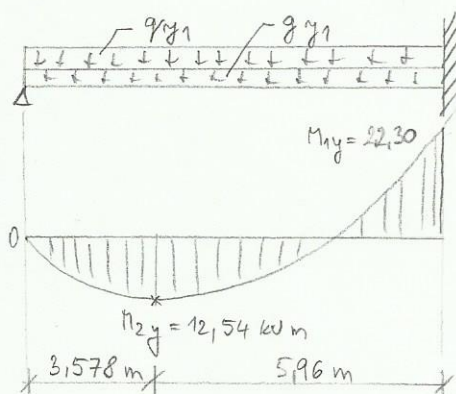
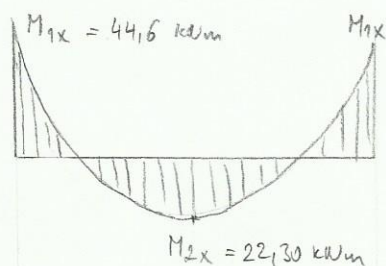
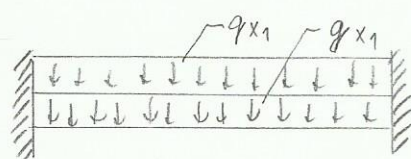
$$6.10 \text{ b)} \quad 0,85 \cdot 1,35 \cdot g_k + 1,5 \cdot q_k = 0,85 \cdot 1,35 \cdot 7,43 + 1,5 \cdot 1,5 = 10,78 \text{ kN/m}^2$$

$$\lambda = \frac{l_{ef,x}^4}{l_{ef,y}^4} = \frac{7,79^4}{9,54^4} = 0,445$$

$$c = \frac{1}{\frac{1}{2} \cdot \lambda + 1} = \frac{1}{\frac{1}{2} \cdot 0,445 + 1} = 0,818$$

$$g_d = 0,85 \cdot 1,35 \cdot g_k = 0,85 \cdot 1,35 \cdot 7,43 = 8,53 \text{ kN/m}^2$$

$$q_d = 1,5 \cdot q_k = 1,5 \cdot 1,5 = 2,25 \text{ kN/m}^2$$



$$g_{x1} = c \cdot g_d = 0,818 \cdot 8,53 = 6,98 \text{ kN/m}^2$$

$$q_{x1} = c \cdot q_d = 0,818 \cdot 2,25 = 1,84 \text{ kN/m}^2$$

$$g_{y1} = (1-c) \cdot g_d = (1-0,818) \cdot 8,53 = 1,55 \text{ kN/m}^2$$

$$q_{y1} = (1-c) \cdot q_d = (1-0,818) \cdot 2,25 = 0,41 \text{ kN/m}^2$$

VNITŘNÍ SÍLY

Směr x:

$$g_{dx} = g_{x1} + q_{x1} = 6,98 + 1,84 = 8,82 \text{ kN/m}^2$$

$$M_{1x} = \frac{1}{12} \cdot g_{dx} \cdot l_{ef,x}^2 = \frac{1}{12} \cdot 8,82 \cdot 7,79^2 = 44,60 \text{ kNm}$$

$$M_{2x} = \frac{1}{24} \cdot g_{dx} \cdot l_{ef,x}^2 = \frac{1}{24} \cdot 8,82 \cdot 7,79^2 = 22,30 \text{ kNm}$$

Směr y:

$$g_{dy} = g_{y1} + q_{y1} = 1,55 + 0,41 = 1,96 \text{ kN/m}^2$$

$$M_{1y} = \frac{1}{8} \cdot g_{dy} \cdot l_{ef,y}^2 = \frac{1}{8} \cdot 1,96 \cdot 9,54^2 = 22,30 \text{ kNm}$$

$$M_{2y} = \frac{9}{128} \cdot g_{dy} \cdot l_{ef,y}^2 = \frac{9}{128} \cdot 1,96 \cdot 9,54^2 = 12,54 \text{ kNm}$$

REDUKCE MOMENTŮ:

$$\alpha = \frac{5}{6} \cdot \frac{l_{ef,x}^2 \cdot l_{ef,y}^2}{l_{ef,x}^4 + l_{ef,y}^4} = \frac{5}{6} \cdot \frac{7,79^2 \cdot 9,54^2}{7,79^4 + 9,54^4} = 0,363$$

$$M_{red,x} = M_{2x} \cdot \left(1 - \frac{2}{3} \alpha\right) = 22,30 \cdot \left(1 - \frac{2}{3} \cdot 0,363\right) = 12,84 \text{ kNm}$$

$$M_{red,y} = M_{2y} \cdot \left(1 - \frac{2}{3} \alpha\right) = 12,54 \cdot \left(1 - \frac{2}{3} \cdot 0,363\right) = 9,51 \text{ kNm}$$

DIMENZOVÁNÍ

XC1

Ø 12

$$c_{\min} = \max \{ c_{\min, \text{diver}}; c_{\min, \text{t}}; 10 \} = \max \{ 10; 12; 10 \} = 12 \text{ mm}$$

$$c_{\text{nom}} = c_{\min} + \Delta c_{\text{def}} = 12 + 10 = 22 \text{ mm}$$

$$c = 25 \text{ mm}$$

MATERIÁLY:

BETON C20/25

OCEĽ B500B

$$f_{cd} = 13,33 \text{ MPa}$$

$$f_{ctm} = 2,2 \text{ MPa}$$

$$f_{yd} = 434,78 \text{ MPa} \quad f_{yk} = 500 \text{ MPa}$$



$$d = h - c - \frac{\varnothing}{2} = 240 - 25 - \frac{12}{2}$$

$$d = 209 \text{ mm}$$

$$d_1 = h - d = 240 - 209 = 31 \text{ mm}$$

NÁVRH A POSOUZENÍ V POLI, SMĚR X :

$$M_{ed, x1} = 12,84 \text{ kNm}$$

$$A_{s, \text{req}} = b \cdot d \cdot \frac{f_{cd}}{f_{yd}} \cdot \left( 1 - \sqrt{1 - \frac{2 M_{ed, x}}{b \cdot d^2 \cdot f_{cd}}} \right) = 1 \cdot 0,209 \cdot \frac{13,33}{434,78} \cdot \left( 1 - \sqrt{1 - \frac{2 \cdot 12,84 \cdot 10^3}{1 \cdot 0,209^2 \cdot 13,33 \cdot 10^6}} \right) = 1,429 \cdot 10^{-4} \text{ m}^2$$

$$\text{NÁVRH: } \varnothing 8 \text{ a' } 140 \text{ mm} \Rightarrow A_{s1} = 2,96 \cdot 10^{-4} \text{ m}^2$$

$$c = 20 \text{ mm}$$

$$d = 240 - 20 - \frac{\varnothing}{2} = 216 \text{ mm}$$

$$d_1 = 25 \text{ mm}$$

$$A_{s, \text{req}} = 1,38 \cdot 10^{-4} \text{ m}^2$$

POSOUZENÍ:

$$\chi = \frac{A_{s1} \cdot f_{yd}}{b \cdot \chi \cdot f_{cd}} = \frac{2,96 \cdot 10^{-4} \cdot 434,78}{1 \cdot 0,8 \cdot 13,33} = 0,012 \text{ m}$$

$$\chi_1 = d - \frac{\chi}{2} = 0,216 - \frac{0,012}{2} = 0,211 \text{ m}$$

$$M_{rd} = f_{yd} \cdot A_{s1} \cdot \chi_1 = 434,78 \cdot 10^3 \cdot 2,96 \cdot 10^{-4} \cdot 0,211 = 27,15 \text{ kNm}$$

$$M_{rd} \geq M_{ed, x1}$$

$$27,15 > 12,84 \text{ kNm} \quad \text{VYHOVÍ}$$

KONSTRUKČNÍ ZÁSADY:

$$A_{s,min} = \max \left\{ 0,26 \cdot \frac{f_{ctm} \cdot b \cdot d}{f_{yk}} ; 0,0013 \cdot b \cdot d \right\} = \max \left\{ 0,26 \cdot \frac{22 \cdot 1 \cdot 0,216}{500} ; 0,0013 \cdot 1 \cdot 0,216 \right\} = \max \left\{ 2,147 \cdot 10^{-4} ; 2,81 \cdot 10^{-4} \right\}$$

$$A_{s,min} = 2,81 \cdot 10^{-4} \text{ m}^2$$

$$A_{s,max} = 0,04 \cdot A_c = 0,04 \cdot 1 \cdot 0,24 = 9,6 \cdot 10^{-3} \text{ m}^2$$

$$A_{s,min} \leq A_s \leq A_{s,max}$$

$$2,81 \cdot 10^{-4} < 2,96 \cdot 10^{-4} < 9,6 \cdot 10^{-3} \text{ m}^2 \quad \text{VYHOVÍ}$$

$$s_{max} = \min \{ 2 \cdot h ; 300 \} = \min \{ 2 \cdot 240 ; 300 \} = 300 \text{ mm}$$

$$s = 170 \text{ mm} < s_{max} = 300 \text{ mm} \quad \text{VYHOVÍ}$$

NÁVRH A POSOUZENÍ VAD PODPOROU, SMĚR X:

$$M_{ed,x,2} = 44,60 \text{ kNm}$$

$$A_{s,req} = 1 \cdot 0,215 \cdot \frac{13,33}{434,78} \cdot \left( 1 - \sqrt{1 - \frac{2 \cdot 44,60 \cdot 10^3}{1 \cdot 0,215^2 \cdot 13,33 \cdot 10^6}} \right) = 4,96 \cdot 10^{-4} \text{ m}^2$$

$$\text{NÁVRH: } \varnothing 10 \text{ a' } 155 \text{ mm} \Rightarrow A_{s1} = 5,07 \cdot 10^{-4} \text{ m}^2$$

POSOUZENÍ

$$x = \frac{5,07 \cdot 10^{-4} \cdot 434,78}{1 \cdot 0,8 \cdot 13,33} = 0,021 \text{ m}$$

$$\alpha_1 = 0,215 - \frac{0,8 \cdot 0,021}{2} = 0,207 \text{ m}$$

$$M_{ed} = 434,78 \cdot 10^3 \cdot 5,07 \cdot 10^{-4} \cdot 0,207 = 45,63 \text{ kNm}$$

$$M_{ed} \geq M_{ed,x,2}$$

$$45,63 > 44,60 \text{ kNm} \quad \text{VYHOVÍ}$$

KĚNÍ ZÁSADY:

$$A_{s,min} = \max \{ 2,46 \cdot 10^{-4} ; 2,80 \cdot 10^{-4} \} = 2,80 \cdot 10^{-4} \text{ m}^2$$

$$A_{s,max} = 9,6 \cdot 10^{-3} \text{ m}^2$$

$$A_{s,min} \leq A_s \leq A_{s,max}$$

$$2,80 \cdot 10^{-4} < 5,07 \cdot 10^{-4} < 9,6 \cdot 10^{-3} \text{ m}^2 \quad \text{VYHOVÍ}$$

$$s = 155 \text{ mm} < s_{max} = 300 \text{ mm}$$

Ø10

$$c = 20 \text{ mm}$$

$$d = 240 - 20 - \frac{10}{2} = 215 \text{ mm}$$

$$d_1 = 25 \text{ mm}$$

NÁVRH A POSOUZENÍ V POLI, SMĚR Y :

$$M_{ed,y,1} = 9,51 \text{ kNm}$$

$$A_{s,req} = 1,02 \cdot 10^{-4} \text{ m}^2$$

$$\text{NÁVRH : } \varnothing 8 \text{ a' } 170 \text{ mm} \Rightarrow A_{s1} = 2,96 \cdot 10^{-4} \text{ m}^2$$

$$x = 0,012 \text{ m}$$

$$x_1 = 0,21 \text{ m}$$

$$M_{rd} = 24,15 \text{ kNm}$$

$$M_{rd} \geq M_{ed,y,1}$$

$$24,15 > 9,51 \text{ kNm} \quad \text{VYHOVUJE}$$

KČENÍ ZÁSADY:

$$A_{s,min} = 2,81 \cdot 10^{-4} \text{ m}^2$$

$$A_{s,max} = 9,6 \cdot 10^{-3} \text{ m}^2$$

$$A_{s,min} \leq A_{s1} \leq A_{s,max}$$

$$2,81 \cdot 10^{-4} < 2,96 \cdot 10^{-4} < 9,6 \cdot 10^{-3} \text{ m}^2$$

$$s = 170 \text{ mm} < s_{max} = 300 \text{ mm} \quad \text{VYHOVUJE}$$

NÁVRH A POSOUZENÍ NAD PODPOROU, SMĚR Y :

$$M_{ed,y,2} = 22,30 \text{ kNm}$$

$$A_{s,req} = 2,42 \cdot 10^{-4}$$

$$\text{NÁVRH : } \varnothing 8 \text{ a' } 170 \text{ mm} \Rightarrow A_{s1} = 2,96 \cdot 10^{-4} \text{ m}^2$$

$$x = 0,012 \text{ m}$$

$$x_1 = 0,21 \text{ m}$$

$$M_{rd} = 24,15 \text{ kNm}$$

$$M_{rd} \geq M_{ed,y,2}$$

$$24,15 > 22,30 \text{ kNm} \quad \text{VYHOVUJE}$$

KČENÍ ZÁSADY:

$$A_{s,min} \leq A_{s1} \leq A_{s,max}$$

$$2,81 \cdot 10^{-4} < 2,96 \cdot 10^{-4} < 9,6 \cdot 10^{-3} \text{ m}^2$$

$$s = 170 \text{ mm} < s_{max} = 300 \text{ mm} \quad \text{VYHOVUJE}$$

KOTVENÍ VÝZTUŽE V POLI, SMĚR X :

$$\sigma_{sd} = \frac{A_{s, req}}{A_s} \cdot f_{yd} = \frac{1,38 \cdot 10^{-4}}{2,96 \cdot 10^{-4}} \cdot 434,78 = 202,40 \text{ MPa}$$

$$l_{brgd} = \frac{\sigma}{4} \cdot \frac{\sigma_{sd}}{f_{bd}} = \frac{8}{4} \cdot \frac{202,40}{2,25} = 180,18 \text{ mm}$$

$$f_{td} = 2,25 \cdot \eta_1 \cdot \eta_2 \cdot f_{ctd} = 2,25 \cdot 1 \cdot 1 \cdot 1 = 2,25 \text{ MPa}$$

$$l_{bd} = \alpha_1 \alpha_2 \alpha_3 \alpha_4 \alpha_5 \cdot l_{brgd} = 0,4 \cdot 1 \cdot 1 \cdot 1 \cdot 1 \cdot 180,18 = 130 \text{ mm}$$

$$l_{b, min} = \max \{ 0,3 \cdot l_{brgd}; 100; 100 \} = \max \{ 54,05; 80; 100 \}$$

$$l_{b, min} = 100 \text{ mm}$$

$$\text{NÁVRH } l_{bd} = 130 \text{ mm} > l_{b, min} = 100 \text{ mm}$$

KOTVENÍ VÝZTUŽE NAD PODPOROU, SMĚR X :

$$\sigma_{sd} = 425,35 \text{ MPa}$$

$$l_{brgd} = 472,61 \text{ mm}$$

$$l_{bd} = 330,23 \text{ mm} \rightarrow \text{NÁVRH } 330 \text{ mm}$$

$$l_{b, min} = \max \{ 141,78; 100; 100 \} = 141,78 \text{ mm}$$

$$l_{bd} = 330 > l_{b, min} = 141,78 \text{ mm}$$

KOTVENÍ VÝZTUŽE V POLI SMĚR Y :

$$\sigma_{sd} = \frac{1,03 \cdot 10^{-4}}{2,91 \cdot 10^{-4}} \cdot 434,78 = 149,82 \text{ MPa}$$

$$l_{brgd} = 133,17 \text{ mm}$$

$$l_{bd} = 93,22 \text{ mm} \sim 110 \text{ mm}$$

$$l_{b, min} = \max \{ 39,95; 80; 100 \} = 100 \text{ mm}$$

$$l_{bd} = 110 > l_{b, min} = 100 \text{ mm}$$

KOTVENÍ VÝZTUŽE NAD PODPOROU, SMĚR Y :

$$\sigma_{sd} = 355,46 \text{ MPa}$$

$$l_{brgd} = 315,96 \text{ mm}$$

$$l_{bd} = 221,18 \text{ mm} \sim 225 \text{ mm}$$

$$l_{b, min} = \max \{ 94,49; 80; 100 \} = 100 \text{ mm} < l_{bd} = 225 \text{ mm}$$