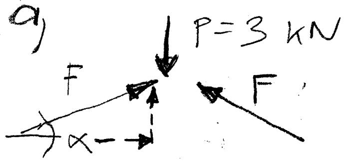
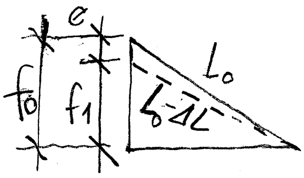
1.

a)



$\alpha = \operatorname{atg} \frac{0{,}4}{5{,}0} = 4{,}57°$

$F = \frac{P}{2 \cdot \sin\alpha} = 18{,}8 \text{ kN}$ $\quad \sigma = \frac{F}{A} = \frac{18{,}8 \cdot 10^3}{100} = 188 \frac{N}{mm^2}$



$\varepsilon = \frac{F}{AE} = \frac{18{,}8 \cdot 10^3}{100 \cdot 200 \cdot 10^3} = 9{,}4 \cdot 10^{-4} = 0{,}94 ‰$

$\Delta L = \varepsilon L_0 = 9{,}4 \cdot 10^{-4} \cdot \sqrt{0{,}4^2 + 5^2} = 9{,}4 \cdot 10^{-4} \cdot \underline{5{,}0160} = 4{,}715 \cdot 10^{-3} \text{ m}$

$f_1 = \sqrt{(L - \Delta L)^2 - l^2} = \sqrt{(5{,}0160 - 0{,}0048)^2 - 5^2} = 0{,}335 \text{ mm}$

$f_1 = 0{,}400 - 0{,}217 = 0{,}183 \text{ m}$

b)

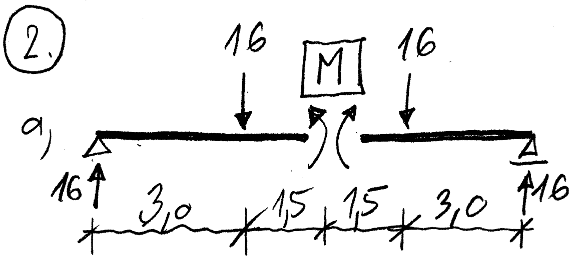
i	f_i [mm]	L_i [m]	F_i [kN]	σ_i [N/mm²]	ε_i [‰]	ΔL [mm]	e_i [mm]
0	400	5,0160	18,8	188	0,94	4,715	65
1	335	5,0113	22,4	224	1,12	5,604	77
2	323	5,0104	23,3	233	1,17	5,831	81
3	319	5,0102	23,6	236	1,18	5,902	$\boxed{82 = e}$

→ $\boxed{318 \text{ mm} = f}$

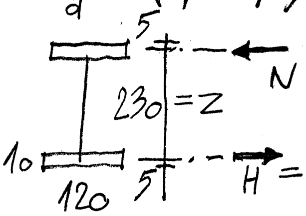
c) több mint duplája $\Delta L = 9{,}43 \text{mm}$, $L_1 = 5{,}006 \text{m} \rightarrow 5 \text{m}$ <u>átpattan</u>

2.

a)



$M_d = 16(4{,}5 - 1{,}5) = 48 \text{ kNm}$



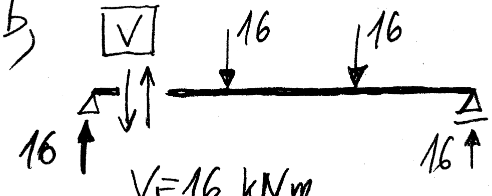
$H = \frac{M}{z} = \frac{48}{0{,}23} = 208{,}7 \text{ kN}$ ✓

$\sigma_d = \frac{H}{A_{öv}} = \frac{208{,}7 \cdot 10^3 N}{10 \cdot 120 \text{ mm}^2} = 174 \frac{N}{mm^2} \leq f_y = 235$ $\boxed{MF}$

<u>Vagy:</u> $M_{R,d} = f_y \cdot b \cdot t_{öv}(h - t_{öv}) = 235 \cdot 120 \cdot 10 (240 - 10) = 64{,}86 \cdot 10^6 \text{ Nmm}$

$M_{R,d} = 64{,}86 \text{ kNm} \geq M_d = 48 \text{ kNm}$ ✓ $\boxed{MF}$

b)

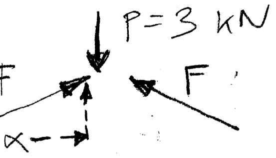


<u>$V_d = 16$ kNm</u>

$\tau_d = \frac{V_d}{A_{öv}} = \frac{16 \cdot 10^3 N}{6 \cdot 220 \text{ mm}^2} = 12{,}12 \text{ N/mm}^2$

$\tau_d = 12{,}12 \frac{N}{mm^2} \ll \tau_y = 135 \frac{N}{mm^2}$ ✓ $\boxed{MF}$

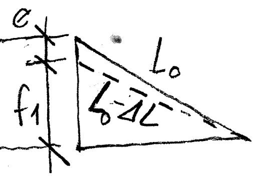
c) felső öv kifordulása, felső öv horpadása, gerinchorpadás



$\alpha = \mathrm{atg}\,\dfrac{0{,}4}{5{,}0} = 4{,}57°$

$F = \dfrac{P}{2\cdot\sin\alpha} = 18{,}8\ kN \qquad \sigma = \dfrac{F}{A} = \dfrac{18{,}8\cdot 10^3}{100} = 188\ \dfrac{N}{mm^2}$

$\varepsilon = \dfrac{F}{AE} = \dfrac{18{,}8\cdot 10^3}{100\cdot 200\cdot 10^3} = 9{,}4\cdot 10^{-4} = 0{,}94‰$



$\Delta L = \varepsilon L_o = 9{,}4\cdot 10^{-4}\cdot\sqrt{0{,}4^2+5^2} = 9{,}4\cdot 10^{-4}\cdot \underline{5{,}0160} = 4{,}715\cdot 10^{-3}\ m$

$f_1 = \sqrt{(L-\Delta L)^2 - L^2} = \sqrt{(5{,}0160-0{,}0048)^2 - 5^2} = 0{,}335\ mm$

$f_1 = 0{,}400 - 0{,}217 = 0{,}183\ m$

i	f_i [mm]	L_i [m]	F_i [kN]	σ_i [$\frac{N}{mm^2}$]	ε_i [‰]	ΔL [mm]	e_i [mm]
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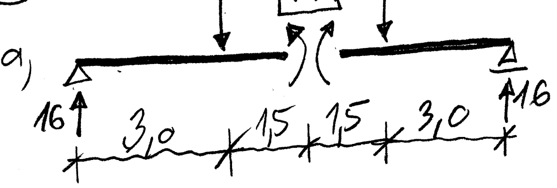
→ $\boxed{318\ mm = f}$

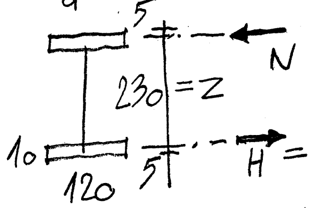
több mint duplája $\Delta L = 9{,}43\ mm$, $L_1 = 5{,}006\ m \to 5\ m$ <u>átpattan</u>

2.

a,



$M_d = 16(4{,}5-1{,}5) = 48\ kNm$



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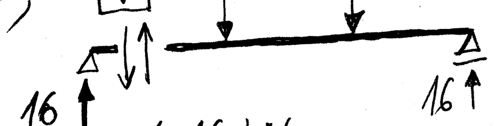
$M_{R,d} = 64{,}86\ kNm \geq M_d = 48\ kNm$ ✓ $\boxed{MF}$

b,



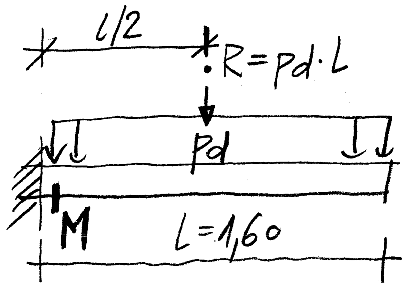
<u>V_d = 16 kNm</u>

$\tau_d = \dfrac{V_d}{A_{öv}} = \dfrac{16\cdot 10^3 N}{6\cdot 220\ mm^2} = 12{,}12\ N/mm^2$

$\tau_d = 12{,}12\ \dfrac{N}{mm^2} \ll \tau_y = 135\ \dfrac{N}{mm^2}$ ✓ $\boxed{MF}$

c, felső öv kifordulása, felső öv horpadása, gerinchorpadás

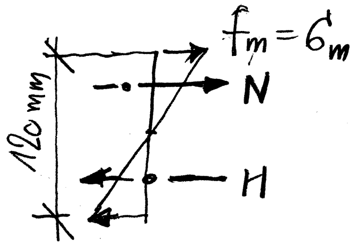
3.



Terhekből (hatás): „EFFECT"

$M_{E,d} = pd\cdot L\cdot\dfrac{L}{2} = \dfrac{pd\cdot L^2}{2}$

Teherbírás (anyag ellenállása): „RESISTANCE"



1 m széles sávot tekintve

$M_{R,d} = \dfrac{bh^2}{6}\cdot f_m = \dfrac{1000\cdot 120^2\ mm^3}{6}\cdot 10\ \dfrac{N}{mm^2}$

szilárdsági feltétel: $M_{R,d} = 24\cdot 10^6\ Nmm = 24\ kNm \geq M_{E,d}$

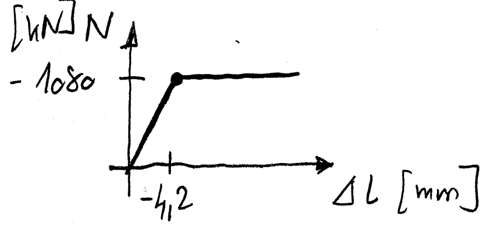
$\dfrac{pd\cdot L^2}{2} \leq M_{R,d} \qquad pd \leq \dfrac{2M_{R,d}}{L^2} = \dfrac{2\cdot 24}{1{,}6^2} = 18{,}75\ \dfrac{kN}{m}$

A felületre: $\boxed{pd \leq 18{,}75\ kN/m^2}$

4.

a, $N_1 = f_c\cdot A_c = 12\ \dfrac{N}{mm^2}\cdot 300^2\ mm^2 = 1{,}08\cdot 10^6\ N = 1080\ kN$

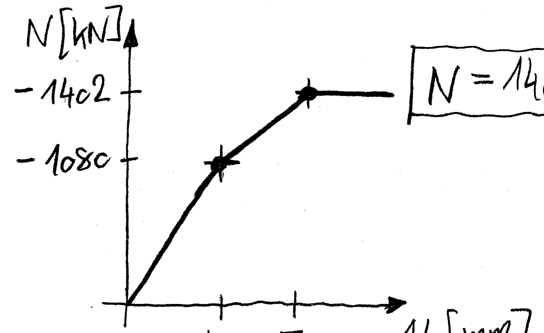
$\Delta L_1 = \varepsilon\cdot L = 0{,}12/100 \times 3500\ mm = 4{,}2\ mm$



b, $N_2 = f_c A_c + f_s\cdot A_s = 12\cdot 300^2 + 400\cdot 4\cdot 201\ mm^2 = 1{,}402\cdot 10^6\ N = 1402\ kN$

Ez a teherbírás $\varepsilon = 0{,}2\%$ összenyomódásnál következik be.

$\Delta L_2 = 0{,}2/100\cdot 3500 = 7{,}0\ mm$

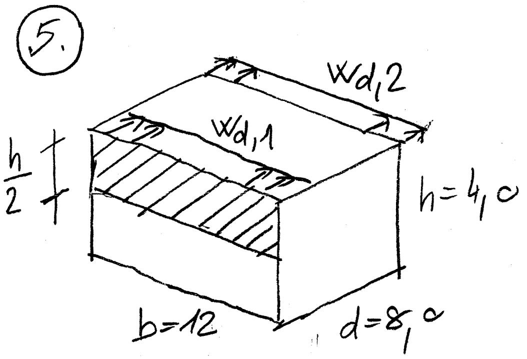


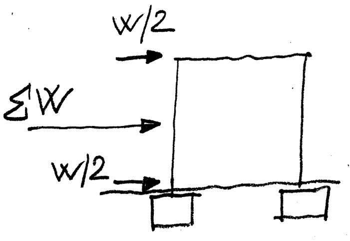
$\boxed{N = 1402\ kN}$ c, keresztmetszet teherbírása

d, a kihajlásveszély miatt nem érhető el a keresztmetszet nyomási teherbírása

→ Oszlop teherbírása <u>kisebb</u> a keresztmetszet teherbírásánál

5.





a, Torló: III. kat. / $h=4{,}0\,m$ / $q_p(z)=0{,}446\ kN/m^2$

Arány: $h/d = 4/8 = 0{,}5 \leq 1$ $\quad c_I=0{,}8 \quad c_{II}=-0{,}5$

$> 0{,}25 \quad c_I=0{,}7 \quad c_{II}=-0{,}3$

interpoláció: szélnyomás: $c_I = 0{,}7+0{,}1\cdot\frac{0{,}25}{0{,}75}=0{,}733$

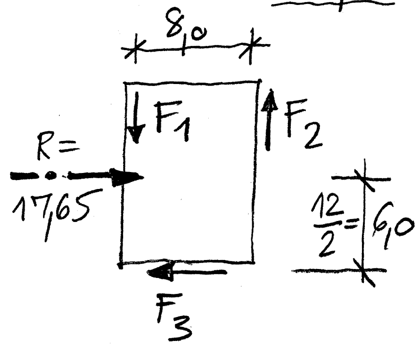
szélszívás: $c_{II} = -0{,}3-0{,}2\cdot\frac{0{,}25}{0{,}75}=-0{,}366$

Szélteher: $w_{d,1}=\gamma_Q\cdot c_I\cdot q_p(z)=1{,}5\cdot 0{,}733\cdot 0{,}446=0{,}4904\ kN/m^2$

$w_{d,2}=\gamma_Q\cdot c_{II}\cdot q_p(z)=1{,}5\cdot 0{,}366\cdot 0{,}446=0{,}2449\ kN/m^2$

$w_d = 0{,}7353\ kN/m^2$

$R_{w,d}=w_d\cdot b\cdot\frac{h}{2}=0{,}7353\cdot 12\cdot 4/2=17{,}65\ kN$



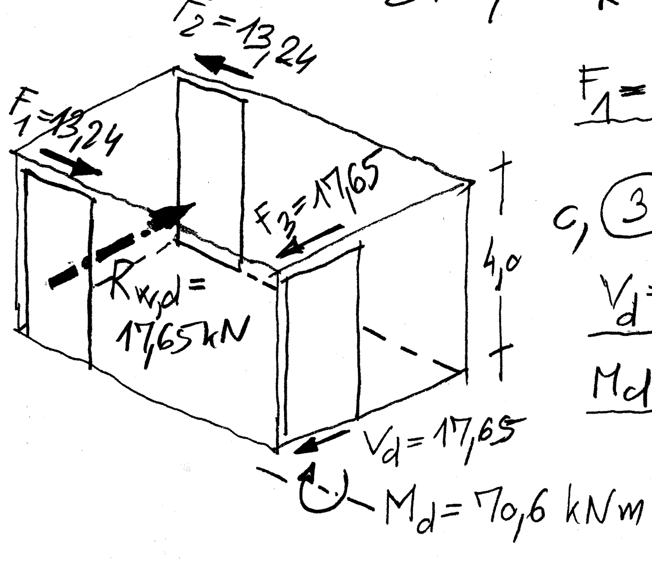
b, Falakra jutó erők – alaprajzban:

$\Sigma X=\emptyset \rightarrow F_3 = R = 17{,}65\ kN\ (\leftarrow)$

$\Sigma Y=\emptyset \rightarrow F_1=F_2$

$\Sigma M=\emptyset \rightarrow R\cdot\frac{b}{2}=F_1\cdot d$

$F_1=F_2=\frac{17{,}65\cdot 6{,}0}{8}=13{,}24\ kN\ (\downarrow)(\uparrow)$



c, 3. fal reakció:

$V_d = F_3 = 17{,}65\ kN$ ($\swarrow$)

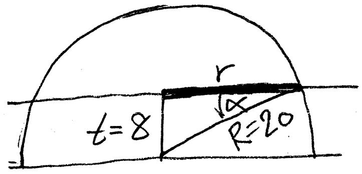
$M_d = F_3 h = 17{,}65\cdot 4{,}0 = 70{,}6\ kNm$ ($\circlearrowright$)

6.

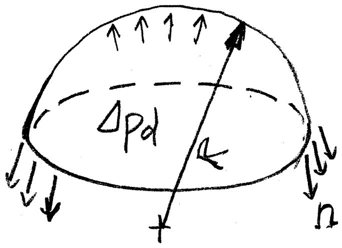
Geometria:

$r=\sqrt{R^2-t^2}=\sqrt{20^2-8^2}=18{,}33\,m$

$\alpha=\arcsin\frac{8}{20}=23{,}6^\circ$



a)

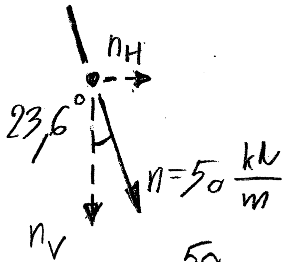


Gömbszelet-támaszerő: érintőirányú

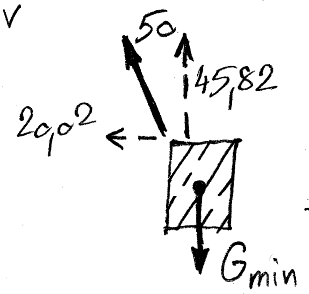
$n_d=\frac{\Delta p_d\cdot R}{2t}\cdot t=\frac{\Delta p_d\cdot R}{2}=\frac{5\,kPa\cdot 20}{2}=50\,\frac{kN}{m}$

$n_{Hd}=n\cdot\sin 23{,}6^\circ=50\cdot\sin 23{,}6^\circ=20{,}02\,\frac{kN}{m}$

$n_{vd}=n\cdot\cos 23{,}6^\circ=50\cdot\cos 23{,}6^\circ=45{,}82\,\frac{kN}{m}$

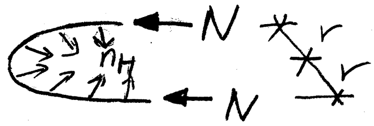


„Fújt" ponyva ~~támasz~~-erői



Ellenerő: vasbeton alapgyűrűt terheli

b, Vízsz. komp.-gyűrűerő veszi fel



$N=n_H\cdot r=20{,}02\cdot 18{,}33=367{,}0\,kN$

nyomás!

c, Függőleges komponens: gyűrű önsúlya egyensúlyozza - stabilitás!

$n_{vd}\leq\gamma_{min}\cdot G=\gamma_{min}\times\gamma_{vb}\times A$

$\boxed{b=1{,}40/h=1{,}50\ m\ \text{gyűrű}}$

$A\geq\frac{n_{vd}}{\gamma_{min}\times\gamma_{vb}}=\frac{45{,}82\,\frac{kN}{m}}{0{,}9\cdot 25\,kN/m^3}=2{,}04\,\frac{m^3}{m}$ $\quad b=\frac{A}{h}=\frac{2{,}04}{1{,}50}=1{,}36\,m$