BREVIAR DE CALCUL

Stabilirea încărcărilor

-incarcarea din zapada

$C_e := 1$ - coeficinetul de expunere al amplasamentului constructiei

$\mu_i := 1$

$S_{ok} := 1.5 \frac{kN}{m^2}$ - valoare caracteristica a incarcarii din zapada pe sol

$C_t := 1$ - coeficientul termic

$S_k := \mu_i \cdot C_e \cdot C_t \cdot S_{ok}$

$S_k = 1.5 \cdot \frac{kN}{m^2}$ - valoare caracteristica a incarcarii din zapada pe acoperis

-incarcari permanente

$\gamma_{bet} := 25 \frac{kN}{m^3}$ - valoare caracteristica a betonului armat

$g_{planseu} := 44 \frac{kN}{m^2}$ - incarcarea provenita din planseu+sapa

$g_{zidarie} := 2 \frac{kN}{m^3}$

-incarcarea utila

$q_{utila} := 2 \frac{kN}{m^2}$ - incarcarea utila

-parametri seismici

$\gamma_I := 1$ - factor de importanta (cladire din clasa de importanta III)

$\beta := 2.5($ - coeficient de amplificare a acceleratiei verticale a miscarii terenului

$q := 3$ - factor de comportare

$a_{g.} := 0.15 g$ - acceleratia terenului pentru proiectare (pentru componenta orizontala a miscarii terenului)

Calcul Sarpanta

Sarpanta se executa din lemn de rasinoase, specia **Brad** , avand :

- densitatea : $\rho =$ 480 [kg/m^3]
- clasa II de exploatare din punct de vedere al conditiilor de umiditate:

Verificarea elementelor se face pentru gruparile corespunzatoare SLU si SLS ,conform indicativului CR 0 - 2005:

SLU: $1{,}35\sum_{j=1}^{n} G_{k,j} + 1{,}5\, Q_{k,1} + \sum_{i=2}^{m} 1{,}5\, \psi_{0,1} Q_{k,i}$, unde $\psi_{0,1} =$ 0,7

SLS: $\sum_{j=1}^{n} G_{k,j} + \psi_{1,1} Q_{k,1} + \sum_{i=2}^{m} \psi_{2,i} Q_{k,i}$, unde $\psi_{1,1} =$ 0,5 si $\psi_{2,i} =$ 0,4 - actiuni din zapada

Invelitoarea este din: tigla ceramica
Panta invelitorii : 30 °

1) Evaluare incarcari:

1.1) incarcari permanente:

- conform SR EN 1991-1-1

Denumire element	Material	Grosime [m]	γ [kN/m^2]	$g_{k,i}$ [kN/m^2]
Invelitoare	tigla	-	-	0.25
Hidroizolatie	folie	-	-	0.05
Astereala	lemn	-	4.8	0.13
Termoizolatie	vata min.	0.000	-	0
Placa inchidere	gips-cart.	0.015	15	0
	Total			0.43

1.2) incarcare din zapada:

- conform indicativului CR 1-1-3 - 2005

- amplasare localitatea: **Paulis** zona : **A** din punct de vedere al zonarii teritorului la actiunea zapezii;

- zona A :	**1.5**	[kN/m^2]
- zona B :	**2.0**	[kN/m^2]
- zona C :	**2.5**	[kN/m^2]
- zona D :	**4.5**	[kN/m^2]

(tab 2.1 p.3)

s_k - valoarea caracteristica a incarcarii din zapada pe acoperis;
$s_k = \mu_i * C_e * C_t * s_{0,k}$

(alt. 1442 m)

C_e = 0.8 - coeficient de expunere al amplasamentului constructiei (tab 2.1 p.5)
C_t = 1.0 - coeficientul termic
$s_{o,k}$= 1.5 - valoarea caracteristica a incarcarii din zapada pe sol in amplasament
μ_i = 1.6 - coeficient de forma pentru incarcarea din zapada pe acoperis (tab 3.1 p.6)

- forma acoperis: **acoperis cu doua pante**

μ_1 = 0.8
μ_2 = 1.6 — $\mu_2 = 0{,}8+0{,}8*\alpha/30$ (tab 3.1 p.6)
μ_3 = 0.4 — $\mu_3 = 0{,}5*\mu_1$

s_k= 1.9 [kN/m^2]

1.3) incarcare din vant:
- conform indicativului NP-082-04

- forma acoperis: acoperis cu doua pante
- amplasare localitatea: Paulis zona : a din punct de vedere al zonarii teritorului la actiunea vantului;

- zona A :	**0.4**	[kN/m²]	(fig.A.2 p.59)
- zona B :	**0.5**	[kN/m²]	(fig.A.2 p.59)
- zona C :	**0.7**	[kN/m²]	(fig.A.2 p.59)
- zona D :	**>0,7**	[kN/m²]	

w(z) - presiune vantului la inaltimea z deasupra terenului;

$w(z)_k = q_{ref} * c_e(z) * c_p$

q_{ref} =	0.4	- presiunea de referinta a vantului	(fig.A.2 p.59)
$c_e(z)$ =	1.8	- factorul de expunere la inaltimea z deasupra terenului	(fig.5 p.13)
$c_{p,min}$=	-1.4	- coeficientul aerodinamic de presiune minim	(cap. 12 p.15)
$c_{p,max}$=	0.7	- coeficientul aerodinamic de presiune maxim	(cap. 12 p.15)

$w(z)_{k\,min}$ = -1.0 [kN/m²]

$w(z)_{k\,max}$ = 0.5 [kN/m²]

1.4) incarcarea utila:
- conform SR EN 1991-1-1

- categoria zonei de incarcare: D - acoperis inaccesibil, exceptand intretinerea si reparatiile normale

q_k = **1.0** [kN/m²]

Q_k = **1.5** [kN]

q_k = 1.0 [kN/m²]

2) Dimensionarea elementelor componente ale sarpantei

- conform EUROCODE 5

2.1) Dimensionarea sipcilor:

- sectiune :	3.8	5.8	b x h [cm]
- distanta dintre sipci:	ds =	0.34	[m]
- distanta dintre capriori:	dc =	0.85	[m]
- clasa de rezistenta a lemnului:		C24	
- unghiul invelitorii :	α =	30	[°]

sinα= 0.500

cosα= 0.866

- verificare la incovoiere oblica si taiere;

2.1.1) Incarcari:
- incarcari de calcul distribuite pe sipca:

- permanente: gr. straturi gr. proprio. sipca
  - $g^{\perp}_k = g_{k,i}*ds + (\rho*b*h)/100$
  - $g^{\perp}_k$ = 0.10 [kN/m]
- din zapada:
  - $s^{\perp}_k = s_k*ds$
  - $s^{\perp}_k$ = 0.65 [kN/m]
- din vant:
  - $w(z)_k^{\perp} = w(z)*ds$
  - $w(z)_k^{\perp}$ = 0.17 [kN/m]

► descompuse pe cele 2 directii y-y si z-z:

♦ permanente:

$g^{\perp}_{k,z} = g_k * \sin\alpha$	=	0.05	[kN/m]
$g^{\perp}_{k,y} = g_k * \cos\alpha$	=	0.08	[kN/m]

♦ din zapada:

$s^{\perp}_{k,z} = s_k * \sin\alpha * \cos\alpha$	=	0.28	[kN/m]
$s^{\perp}_{k,y} = s_k * \cos^2\alpha$	=	0.49	[kN/m]

♦ din vant:

$w(z)^{\perp}_{k,z} = 0$	=	0.00	[kN/m]
$w(z)^{\perp}_{k,y} = w(z)$	=	0.17	[kN/m]

2.1.2) Rezistentele lemnului:

- caracteristice:

$f_{m,k}$ =	24	[N/mm²]
$f_{c,0,k}$ =	21	[N/mm²]
$f_{c,90,k}$ =	5.3	[N/mm²]
$f_{v,k}$ =	2.5	[N/mm²]

- de calcul:

$$k_{mod} = \frac{k_{modgk} \times 1{,}35 \times g_k + k_{modsk} \times 1{,}5 \times s_k + k_{modwk} \times 1{,}05 \times w_k}{1{,}35 \times g_k + 1{,}5 \times s_k + 1{,}05 w_k}$$

$f_{m,d}$ =	16	[N/mm²]	$k_{mod,gk}$ = 0.6
$f_{c,0,d}$ =	14	[N/mm²]	$k_{mod,sk}$ = 0.9
$f_{c,90,d}$ =	3	[N/mm²]	γ_m = 1.3 (cf. EC 5)
$f_{v,d}$ =	2	[N/mm²]	$k_{mod,wk}$ = 0.9

k_{mod} = 0.850

2.1.3) Modul de elasticitate:

$E_{0,m}$ =	11	[kN/mm²]
$E_{0,05}$ =	7.4	[kN/mm²]
$E_{90,m}$ =	0.37	[kN/mm²]

2.1.4) Caracteristici sectionale:

W_z =	21.305	[cm³]
W_y =	13.959	[cm³]
I_z =	61.785	[cm⁴]
I_y =	26.521	[cm⁴]

$$W_z = \frac{b \times h^2}{6} \qquad I_z = \frac{b \times h^3}{12}$$

$$W_y = \frac{b^2 \times h}{6} \qquad I_y = \frac{b^3 \times h}{12}$$

2.1.5) Verificari:

2.1.5.1) Incovoiere:

$M_{g,k,y}$ =	0.01	[kNm]
$M_{s,k,y}$ =	0.04	[kNm]
$M_{w,k,y}$ =	0.02	[kNm]
$M_{d,y}$ =	0.09	[kNm]
$M_{g,k,z}$ =	0.00	[kNm]
$M_{s,k,z}$ =	0.03	[kNm]
$M_{w,k,z}$ =	0.00	[kNm]
$M_{d,z}$ =	0.04	[kNm]
$\sigma_{m,d,y}$ =	6640	[kN/m^2]
$\sigma_{m,d,z}$ =	2070	[kN/m^2]
$k_{mod,y}$ =	0.867	[-]
$k_{mod,z}$ =	0.860	[-]
k_h =	1.209	[-]
k_{crit} =	1.000	[-]
$\lambda_{rel,m}$ =	0.36	[-]
$\sigma_{m,crit}$ =	162560	[kN/m^2]
$f_{m,d,y}$ =	21299.93	[kN/m^2]
$f_{m,d,z}$ =	21129.38	[kN/m^2]

$$M_{gk.y} = \frac{g_{k.y}^{-} \times d_c^2}{8}$$

$$M_{sk.y} = \frac{s_{k.y}^{-} \times d_c^2}{8}$$

$$M_{wk.y} = \frac{w_{k.y}^{-} \times d_c^2}{8}$$

$$M_{d.y} = 1{,}35 \times M_{gk.y} + 1{,}5 \times M_{sk.y} + 1{,}05 \times M_{wk.y}$$

$$M_{gk.z} = \frac{g_{k.z}^{-} \times d_c^2}{8}$$

$$M_{sk.z} = \frac{s_{k.z}^{-} \times d_c^2}{8}$$

$$M_{wk.z} = \frac{w_{k.z}^{-} \times d_c^2}{8}$$

$$M_{d.z} = 1{,}35 \times M_{gk.z} + 1{,}5 \times M_{sk.z} + 1{,}05 \times M_{wk.z}$$

$$\sigma_{m.dy} = \frac{M_{d.y}}{W_y}$$

$$\sigma_{m.dz} = \frac{M_{d.z}}{W_z}$$

$k_h = \min\{(150/h)^{0.2}; 1{,}3\}$ - coef de inaltime

$$k_{crit} = \begin{cases} 1 \; pt \; \lambda_{rel.m} \leq 0{,}75 \\ 1{,}56 - 0{,}75 \times \lambda_{rel.m} \; pt \; 0{,}75 < \lambda_{rel.m} \leq 1{,}4 \\ \frac{1}{\lambda_{rel.m}^2} \; pt \; \lambda_{rel.m} > 1{,}4 \end{cases}$$

- coeficient care ia in considerare reducerea rezistentei datrita fenomenului de instabilitate laterala

$\lambda_{rel.m} = \sqrt{\frac{f_{m.k}}{\sigma_{m\,crit}}} \times m$ - zveltetea relativa

$$\sigma_{m.crit} = 0{,}75 \times E_{0.05} \times \frac{b^2}{h \times d_c}$$

- efortul critic determinat pt E=E0,05 si tine cont de factorul „m" de transformare

$$f_{m.dy} = (k_{mod.y} \times f_k \times k_{crit} \times k_{1s} \times k_h)/\gamma_M$$

$$f_{m.dz} = (k_{mod.z} \times f_k \times k_{crit} \times k_{1s} \times k_h)/\gamma_M$$

k_{1s} = 1.1 - coeficient care ia in considerare efectul sistemului asupra capacitatii portante

$$k_{mod.y} = \frac{k_{mod.gk} \times g_{k.y}^{-} \times 1{,}35 + k_{mod.sk} \times s_{k.y}^{-} \times 1{,}5 + k_{mod.wk} \times w_{k.y}^{-} \times 1{,}05}{1{,}35 \times g_{k.y}^{-} + 1{,}5 \times s_{k.y}^{-} + 1{,}05 \times w_{k.y}^{-}}$$

$$k_{mod.z} = \frac{k_{mod.gk} \times g_{k.z}^{-} \times 1{,}35 + k_{mod.sk} \times s_{k.z}^{-} \times 1{,}5 + k_{mod.wk} \times w_{k.z}^{-} \times 1{,}05}{1{,}35 \times g_{k.z}^{-} + 1{,}5 \times s_{k.z}^{-} 1{,}05 \times w_{k.z}^{-}}$$

$\sigma_{m,d,y} < f_{m,d,y}$ VERIFICA

$\sigma_{m,d,z} < f_{m,d,z}$ VERIFICA

$$k_m \times \left(\frac{\sigma_{m.dz}}{f_{md.z}}\right) + \frac{\sigma_{m.dy}}{f_{md.y}} \leq 1,0$$ VERIFICA

$$k_m \times \left(\frac{\sigma_{m.dy}}{f_{md.y}}\right) + \frac{\sigma_{m.dz}}{f_{md.z}} \leq 1,0$$ VERIFICA

$$k_m = \begin{Bmatrix} 0,7 \text{ pt sectiuni rectangulare} \\ 1 \text{ pt alte sectiuni transversale} \end{Bmatrix}$$

- factor de combinare a rezistentelor rezistentelor la incovoiere care ia in considerare efectul incovoierii biaxiale

2.1.5.2) Forfecare:

$V_{g,k,y}$ =	0.04	[kN]
$V_{s,k,y}$ =	0.21	[kN]
$V_{w,k,y}$ =	0.07	[kN]
$V_{d,y}$ =	0.44	[kN]
$V_{g,k,z}$ =	0.02	[kN]
$V_{s,k,z}$ =	0.12	[kN]
$V_{w,k,z}$ =	0.00	[kN]
$V_{d,z}$ =	0.21	[kN]
$\tau_{d,y}$ =	297	[kN/m²]
$\tau_{d,z}$ =	141	[kN/m²]
$f_{v,d,y}$ =	1090.16	[kN/m²]
$f_{v,d,z}$ =	1081.43	[kN/m²]

$$V_{gk.y} = \frac{g_{k.y} \times d_c}{2} \qquad V_{wk.y} = \frac{w_{k.y} \times d_c}{2}$$

$$V_{sk.y} = \frac{s_{k.y} \times d_c}{2}$$

$$V_{d.y} = 1,35 \times V_{gk.y} + 1,5 \times V_{sk.y} + 1,05 \times V_{wk.y}$$

$$V_{gk.z} = \frac{g_{k.z} \times d_c}{2} \qquad V_{wk.z} = \frac{w_{k.z} \times d_c}{2}$$

$$V_{sk.z} = \frac{s_{k.z} \times d_c}{2}$$

$$V_{d.z} = 1,35 \times V_{gk.z} + 1,5 \times V_{sk.z} + 1,05 \times V_{wk.z}$$

$$\tau_{dy} = \frac{1,5 \times V_{d.y}}{b \times h}$$

$$\tau_{dz} = \frac{1,5 \times V_{d.z}}{b \times h}$$

$$f_{\vartheta.dy} = k_{mod.y} \times \frac{f_{\vartheta.k}}{\gamma_M}$$

$$f_{\vartheta.dz} = k_{mod.z} \times \frac{f_{\vartheta.k}}{\gamma_M}$$

k_v = 1 $\quad \tau_d < k_\vartheta \times f_{\vartheta.d}$

$\tau_{d,y} < f_{v,d,y}$ VERIFICA

$\tau_{d,z} < f_{v,d,z}$ VERIFICA

2.1.5.3) Deformatii:

2.1.5.3.1) Faza initiala (instantanee):

$U_{g,inst,y}$ =	0.00029	[m]
$U_{g,inst,z}$ =	0.00007	[m]
$U_{s,inst,y}$ =	0.00170	[m]
$U_{s,inst,z}$ =	0.00042	[m]
$U_{w,inst,y}$ =	0.00059	[m]
$U_{w,inst,z}$ =	0.00000	[m]
d_c / 300 =	0.00283	[m]

$$u_{g,inst,y} = \frac{5}{384} \times \frac{g_{k,y} \times d_c^4}{E_{0.05} \times I_y}$$

$$u_{g,inst,z} = \frac{5}{384} \times \frac{g_{k,z} \times d_c^4}{E_{0.05} \times I_z}$$

$$u_{s,inst,y} = \frac{5}{384} \times \frac{s_{k,y} \times d_c^4}{E_{0.05} \times I_y}$$

$$u_{s,inst,z} = \frac{5}{384} \times \frac{s_{k,z} \times d_c^4}{E_{0.05} \times I_z}$$

$$u_{w,inst,y} = \frac{5}{384} \times \frac{w_{k,y} \times d_c^4}{E_{0.05} \times I_y}$$

$$u_{w,inst,z} = \frac{5}{384} \times \frac{w_{k,z} \times d_c^4}{E_{0.05} \times I_z}$$

$U_{g,inst,y}$ < dc / 300	VERIFICA
$U_{g,inst,z}$ < dc / 300	VERIFICA
$U_{s,inst,y}$ < dc / 300	VERIFICA
$U_{s,inst,z}$ < dc / 300	VERIFICA
$U_{w,inst,y}$ < dc / 300	VERIFICA
$U_{w,inst,z}$ < dc / 300	VERIFICA

2.1.5.3.2) Faza finala:

$U_{g,fin,y}$ =	0.00052	[m]
$U_{g,fin,z}$ =	0.00013	[m]
$U_{s,fin,y}$ =	0.00212	[m]
$U_{s,fin,z}$ =	0.00053	[m]
$U_{w,fin,y}$ =	0.00059	[m]
$U_{w,fin,z}$ =	0.00000	[m]
d_c / 200 =	0.00425	[m]
$U_{fin,y}$ =	0.00323	[m]
$U_{fin,z}$ =	0.00065	[m]
$U_{net,fin}$ =	0.00330	[m]

$$u_{g,fin,y} = u_{g,inst,y}(1 + k_{def,gk,y})$$

$$u_{g,fin,z} = u_{g,inst,z}(1 + k_{def,gk,z})$$

$$u_{s,fin,y} = u_{s,inst,y}(1 + k_{def,sk,y})$$

$$u_{s,fin,z} = u_{s,inst,z}(1 + k_{def,sk,z})$$

$$u_{w,fin,y} = u_{w,inst,y}(1 + k_{def,sk,y})$$

$$u_{w,fin,z} = u_{w,inst,z}(1 + k_{def,sk,z})$$

$$u_{fin,y} = u_{s,fin,y} + u_{g,fin,y} + u_{w,fin,y}$$

$$u_{fin,z} = u_{s,fin,z} + u_{g,fin,z} + u_{w,fin,z}$$

$$u_{net,fin} = \sqrt{(u_{fin,y}^2 + u_{fin,z}^2)}$$

$U_{g,fin,y} < dc / 200$	VERIFICA
$U_{g,fin,z} < dc / 200$	VERIFICA
$U_{s,fin,y} < dc / 200$	VERIFICA
$U_{s,fin,z} < dc / 200$	VERIFICA
$U_{w,fin,y} < dc / 200$	VERIFICA
$U_{w,fin,z} < dc / 200$	VERIFICA
$U_{fin,y} < dc / 200$	VERIFICA
$U_{fin,z} < dc / 200$	VERIFICA
$U_{net,fin} < dc / 200$	VERIFICA

2.2) Dimensionarea capriorilor:

- sectiune :		[cm]	b =	10	h =	15
-distanta dintre capriori:	dc =	0.80	[m]			
-deschiderea maxima pe directia inclinata:	lc =	2.30	[m]			
-deschiderea maxima pe directia orizontala:	d =	1.99	[m]			
- clasa de rezistenta a lemnului:		C30				

-verificare la incovoiere dreapta si forfecare;

2.2.1) Incarcari:

- incarcari de calcul distribuite pe caprior:

♦ permanente:

-nr. sipci preluate de caprior: **n =** 8 buc. $n = \frac{l_c}{d_s} + 1$

(gr. straturi — greutate sipci — gr. proprie capriori)

$g^{\perp}_k = [g_{k,i} \cdot dc + (n \cdot \rho \cdot b \cdot h)/100 + (\rho \cdot b \cdot h)/100] \cdot \cos\alpha$

$g^{\perp}_k =$ 0.50 [kN/m]

♦ din zapada:

$s^{\perp}_k = s_k \cdot dc \cdot \cos^2\alpha$

$s^{\perp}_k =$ 1.15 [kN/m]

♦ vant:

$w(z)_k^{\perp} = w(z)_k \cdot dc$

$w(z)_k^{\perp} =$ 0.40 [kN/m]

2.2.2) Rezistentele lemnului:

- caracteristice:

$f_{m,k} =$	30	[N/mm²]
$f_{c,0,k} =$	23	[N/mm²]
$f_{c,90,k} =$	5.7	[N/mm²]
$f_{v,k} =$	3	[N/mm²]

- de calcul:

$$k_{mod} = \frac{k_{mod.gk} \times 1{,}35 \times g_k + k_{mod.sk} \times 1{,}5 \times s_k + k_{mod.wk} \times 1{,}05 \times w_k}{1{,}35 \times g_k + 1{,}5 \times s_k + 1{,}05 w_k}$$

$f_{m,d}$ = 8 [N/mm²]
$f_{c,0,d}$ = 6 [N/mm²]
$f_{c,90,d}$ = 2 [N/mm²]
$f_{v,d}$ = 1 [N/mm²]
k_{mod} = 0.353

$k_{mod,gk}$ = 0.6
$k_{mod,sk}$ = 0.9
γ_m = 1.3 (cf. EC 5)
$k_{mod,wk}$ = 0.9

2.2.3) Modul de elasticitate:

$E_{0,m}$ = 12 [kN/mm²]
$E_{0,05}$ = 8 [kN/mm²]
$E_{90,m}$ = 0.4 [kN/mm²]

2.2.4) Caracteristici sectionale:

W = 250.000 [cm³]
I = 2812.500 [cm⁴]

$$W = \frac{h^2 \times b}{6} \qquad I = \frac{b \times h^3}{12}$$

2.2.5) Verificari:

2.2.5.1) Incovoiere:

$M_{g,k}$ = 0.33 [kNm]
$M_{s,k}$ = 0.76 [kNm]
$M_{w,k}$ = 0.27 [kNm]
M_d = 1.87 [kNm]
$\sigma_{m,d}$ = 7470 [kN/m²]
k_{mod} = 0.829 [-]
k_h = 1.000 [-]
k_{crit} = 1.000 [-]
$\lambda_{rel,m}$ = 0.39 [-]
$\sigma_{m,crit}$ = 173913 [kN/m²]
$f_{m,d}$ = 21032.91 [kN/m²]

$$M_{gk} = \frac{g_k \times l_c^2}{8} \qquad M_{wk} = \frac{w_k \times l_c^2}{8}$$

$$M_{sk} = \frac{s_k \times l_c^2}{8}$$

$$M_d = 1{,}35 \times M_{gk} + 1{,}5 \times M_{sk} + 1{,}05 \times M_{wk}$$

$$\sigma_{m.d} = \frac{M_d}{W}$$

$$f_{m.d} = (k_{mod} \times f_k \times k_{crit} \times k_{1s} \times k_h)/\gamma_M$$

$k_h = \min\{(150/h)^{0.2}; 1{,}3\}$ - coef de inaltime

$$k_{crit} = \begin{cases} 1 \text{ pt } \lambda_{rel.m} \le 0{,}75 \\ 1{,}56 - 0{,}75 \times \lambda_{rel.m} \text{ pt } 0{,}75 < \lambda_{rel.m} \le 1{,}4 \\ \frac{1}{\lambda_{rel.m}^2} \text{ pt } \lambda_{rel.m} > 1{,}4 \end{cases}$$

- coeficient care ia in considerare reducerea rezistentei datrita fenomenului de instabilitate laterala

$\lambda_{rel.m} = \sqrt{\frac{f_{m.k}}{\sigma_{m.crit}}} \times m$ - zveltetea relativa

$\sigma_{m.crit} = 0{,}75 \times E_{0.05} \times \frac{b^2}{h \times d_c}$

- efortul critic determinat pt E=E0,05 si tine cont de factorul „m" de transformare

k_{1s} = 1.1 - coeficient care ia in considerare efectul sistemului asupra capacitatii portante

$$k_{mod} = \frac{k_{mod.gk} \times 1{,}35 \times g_k + k_{mod.sk} \times 1{,}5 \times s_k + k_{mod.wk} \times 1{,}05 \times w_k}{1{,}35 \times g_k + 1{,}5 \times s_k + 1{,}05 \times w_k}$$

$\sigma_{m,d} < f_{m,d}$ VERIFICA

2.2.5.2) Forfecare:

$V_{g,k}$ =	0.57	[kN]
$V_{s,k}$ =	1.33	[kN]
$V_{w,k}$ =	0.46	[kN]
V_d =	3.25	[kN]
τ_d =	325	[kN/m²]
$f_{v,d}$ =	1912.08	[kN/m²]

$$V_{gk} = \frac{g_k^{+} \times l_c}{2} \qquad V_{wk} = \frac{w_k^{+} \times l_c}{2}$$

$$V_{sk} = \frac{s_k^{+} \times l_c}{2}$$

$$V_d = 1{,}35 \times V_{gk} + 1{,}5 \times V_{sk} + 1{,}05 V_{wk}$$

$$\tau_d = \frac{1{,}5 \times V_d}{b \times h}$$

$$f_{\vartheta.d} = k_{mod} \times \frac{f_{\vartheta.k}}{\gamma_M}$$

k_v = 1 $\qquad \tau_d < k_{\vartheta} \times f_{\vartheta.d}$

$\tau_d < f_{v,d}$ VERIFICA

2.2.5.3) Deformatii:

2.2.5.3.1) Faza initiala (instantanee):

$U_{g,inst}$ =	0.00081	[m]
$U_{s,inst}$ =	0.00187	[m]
$U_{w,inst}$ =	0.00065	[m]
l_c / 300 =	0.00767	[m]

$$u_{g.inst} = \frac{5}{384} \times \frac{g_k^{+} \times l_c^4}{E_{0.05} \times I}$$

$$u_{s.inst} = \frac{5}{384} \times \frac{s_k^{+} \times l_c^4}{E_{0.05} \times I}$$

$$u_{w.inst} = \frac{5}{384} \times \frac{w_k^{+} \times l_c^4}{E_{0.05} \times I}$$

$U_{g,inst}$ < lc / 300 VERIFICA

$U_{s,inst}$ < lc / 300 VERIFICA

$U_{w,inst}$ < lc / 300 VERIFICA

2.2.5.3.2) Faza finala:

$U_{g,fin}$ =	0.00145	[m]
$U_{s,fin}$ =	0.00233	[m]
$U_{w,fin}$ =	0.00065	[m]
l_c / 200 =	0.01150	[m]
U_{fin} =	0.00444	[m]

$$u_{g.fin} = u_{g.inst}(1 + k_{def.gk})$$

$$u_{s.fin} = u_{s.inst}(1 + k_{def.sk})$$

$$u_{w.fin} = u_{w.inst}(1 + k_{def.wk})$$

$$u_{fin} = u_{s.fin} + u_{g.fin} + u_{w.fin}$$

$U_{g,fin}$ < lc / 200 VERIFICA

$U_{s,fin}$ < lc / 200 VERIFICA

$U_{u,fin}$ < lc / 200 VERIFICA

U_{fin} < lc / 200 VERIFICA

2.3) Dimensionarea panelor:

- sectiune :	[cm]	b =	15	h =	30

-traveea:	T =	4.80	[m]
-dist. echiv. de pe care sunt preluate incarcarile:	D =	1.75	[m]
- clasa de rezistenta a lemnului:		C24	

-verificare la incovoiere dreapta si forfecare;

2.3.1) Incarcari:

- incarcari de calcul distribuite pe pana:

♦ permanente:

-nr. capriori preluat de pana: **n =** 7 buc. $n = \frac{T}{d_c} + 1$

$g^{\perp}_k = (n \cdot g_{k,\,caprior} \cdot D)/T + (\rho \cdot b \cdot h)/100$ (inc. aduse de caprior; gr. proprie pana)

$g^{\perp}_k =$ 1.49 [kN/m]

♦ din zapada:

$s^{\perp}_k = s_k \cdot D$

$s^{\perp}_k =$ 3.36 [kN/m]

♦ utila:

$w(z)_k^{\perp} = w(z)_k \cdot D \cdot \cos\alpha$

$w(z)_k^{\perp} =$ 0.76 [kN/m]

2.3.2) Rezistentele lemnului:

- caracteristice:

$f_{m,k} =$ 24 [N/mm^2]
$f_{c,0,k} =$ 21 [N/mm^2]
$f_{c,90,k} =$ 5.3 [N/mm^2]
$f_{v,k} =$ 2.5 [N/mm^2]

- de calcul:

$$k_{mod} = \frac{k_{modgk} \times g_{k.}^{\perp} \times 1{,}35 + k_{modsk} \times s_{k.}^{\perp} \times 1{,}5 + 1{,}05 \times U_k^{\perp} \times k_{modgk}}{1{,}35 \times g_{k.y}^{\perp} + 1{,}5 \times s_{k.y}^{\perp} + 1{,}05 \times U_k^{\perp}}$$

$f_{m,d} =$ 15 [N/mm^2]	$k_{mod,\,gk} =$ 0.6	
$f_{c,0,d} =$ 13 [N/mm^2]	$k_{mod,\,sk} =$ 0.9	
$f_{c,90,d} =$ 3 [N/mm^2]	$\gamma_m =$ 1.3	(cf. EC 5)
$f_{v,d} =$ 2 [N/mm^2]	$k_{mod,\,wk} =$ 0.9	

$k_{mod} =$ 0.823

2.3.3) Modul de elasticitate:

$E_{0,m} =$ 11 [kN/mm^2]
$E_{0,05} =$ 7.4 [kN/mm^2]
$E_{90,m} =$ 0.37 [kN/mm^2]

2.3.4) Caracteristici sectionale:

$W =$ 2250.000 [cm^3]
$I =$ 33750.000 [cm^4]

$$W = \frac{h^2 \times b}{6} \qquad I = \frac{b \times h^3}{12}$$

2.3.5) Verificari:

2.3.5.1) Incovoiere:

$M_{g,k} =$	4.28	[kNm]
$M_{s,k} =$	9.68	[kNm]
$M_{w,k} =$	2.20	[kNm]
$M_d =$	22.61	[kNm]
$\sigma_{m,d} =$	10048	[kN/m^2]
$k_{mod} =$	0.823	[-]
$k_h =$	0.871	[-]
$k_{crit} =$	1.000	[-]
$\lambda_{rel,m} =$	0.49	[-]
$\sigma_{m,crit} =$	86719	[kN/m^2]
$f_{m,d} =$	14554.42	[kN/m^2]

$$M_{gk} = \frac{g_k \times T^2}{8}$$

$$M_{sk} = \frac{s_k \times T^2}{8}$$

$$M_{wk} = \frac{w_k \times T^2}{8}$$

$$M_d = 1{,}35 \times M_{gk} + 1{,}5 \times M_{sk} + 1{,}05 \times M_{wk}$$

$$\sigma_{m.d} = \frac{M_d}{W}$$

$$f_{m.d} = (k_{mod} \times f_k \times k_{crit} \times k_{1s} \times k_h)/\gamma_M$$

$k_h = \min\{(150/h)^{0,2}\,;1{,}3\}$ - coef de inaltime

$$k_{crit} = \begin{cases} 1 \; pt\; \lambda_{rel.m} \leq 0{,}75 \\ 1{,}56 - 0{,}75 \times \lambda_{rel.m} \; pt \; 0{,}75 < \lambda_{rel.m} \leq 1{,}4 \\ \frac{1}{\lambda_{rel.m}^2} \; pt \; \lambda_{rel.m} > 1{,}4 \end{cases}$$

- coeficient care ia in considerare reducerea rezistentei datrita fenomenului de instabilitate laterala

$\lambda_{rel.m} = \sqrt{\frac{f_{m.k}}{\sigma_{m.crit}}} \times m$ - zveltetea relativa

$\sigma_{m.crit} = 0{,}75 \times E_{0.05} \times \frac{b^2}{h \times D}$

- efortul critic determinat pt E=E0,05 si tine cont de factorul „m" de transformare

$k_{1s} =$ 1.1 - coeficient care ia in considerare efectul sistemului asupra capacitatii portante

$$k_{mod} = \frac{k_{modgk} \times 1{,}35 \times g_k + k_{modsk} \times 1{,}5 \times s_k + k_{modwk} \times 1{,}05 \times w_k}{1{,}35 \times g_k + 1{,}5 \times s_k + 1{,}05 \times w_k}$$

$\sigma_{m,d} < f_{m,d}$ **VERIFICA**

2.3.5.2) Forfecare:

$V_{g,k}$ =	3.57	[kN]
$V_{s,k}$ =	8.06	[kN]
$V_{w,k}$ =	1.83	[kN]
V_d =	18.84	[kN]
τ_d =	628	[kN/m²]
$f_{v,d}$ =	1583.20	[kN/m²]

$$V_{gk} = \frac{g_k^{\perp} \times T}{2}$$
$$V_{sk} = \frac{s_k^{\perp} \times T}{2}$$
$$V_{wk} = \frac{w_k^{\perp} \times T}{2}$$
$$V_d = 1{,}35 \times V_{gk} + 1{,}5 \times V_{sk} + 1{,}05 V_{wk}$$
$$\tau_d = \frac{1{,}5 \times V_d}{b \times h}$$
$$f_{\vartheta,d} = k_{mod} \times \frac{f_{\vartheta,k}}{\gamma_M}$$

k_v = 1 $\qquad \tau_d < k_\vartheta \times f_{\vartheta,d}$

$\tau_d < f_{v,d}$ **VERIFICA**

2.3.5.3) Deformatii:

2.3.5.3.1) Faza initiala (instantanee):

$U_{g,inst}$ =	0.00412	[m]
$U_{s,inst}$ =	0.00930	[m]
$U_{w,inst}$ =	0.00211	[m]
T / 300 =	0.01600	[m]

$$u_{g,inst} = \frac{5}{384} \times \frac{g_k^{\perp} \times T^4}{E_{0.05} \times I}$$
$$u_{s,inst} = \frac{5}{384} \times \frac{s_k^{\perp} \times T^4}{E_{0.05} \times I}$$
$$u_{w,inst} = \frac{5}{384} \times \frac{w_k^{\perp} \times T^4}{E_{0.05} \times I}$$

$U_{g,inst} < T / 300$ **VERIFICA**

$U_{s,inst} < T / 300$ **VERIFICA**

$U_{u,inst} < T / 300$ **VERIFICA**

2.3.5.3.2) Faza finala:

$U_{g,fin}$ =	0.00741	[m]
$U_{s,fin}$ =	0.01162	[m]
$U_{u,fin}$ =	0.00211	[m]
T / 200 =	0.02400	[m]
U_{fin} =	0.02115	[m]

$$u_{g,fin} = u_{g,inst}(1 + k_{def,gk})$$
$$u_{s,fin} = u_{s,inst}(1 + k_{def,sk})$$
$$u_{w,fin} = u_{w,inst}(1 + k_{def,wk})$$
$$u_{fin} = u_{s,fin} + u_{g,fin} + u_{w,fin}$$

$U_{g,fin} < T / 200$	VERIFICA
$U_{s,fin} < T / 200$	VERIFICA
$U_{u,fin} < T / 200$	VERIFICA
$U_{fin} < T / 200$	VERIFICA

2.4) Dimensionarea popilor:

- sectiune : [cm] b = 15 h = 15

-inaltime pop : l_p = 2.00 [m]

- clasa de rezistenta a lemnului: C24

-verificare la flambaj si compresiune (paralela cu fibrele);

2.4.1) Incarcari:

- incarcari de calcul distribuite pe pop:

♦ permanente: (inc. aduse de pana; gr. proprie pop)

$g^{\perp}_k = g_{k,\,pana} \cdot T + (\rho \cdot b \cdot h \cdot l_p)/100$

$g^{\perp}_k =$ 7.36 [kN]

♦ din zapada:

$s^{\perp}_k = s_k \cdot T \cdot D \cdot \cos\alpha$

$s^{\perp}_k =$ 13.97 [kN]

♦ utila:

$w(z)_k^{\perp} = w(z)_k \cdot T \cdot D \cdot \cos\alpha$

$w(z)_k^{\perp} =$ 3.67 [kN]

2.4.2) Rezistentele lemnului:

- caracteristice:

$f_{m,k} =$ 24 [N/mm^2]

$f_{c,0,k} =$ 21 [N/mm^2]

$f_{c,90,k} =$ 5.3 [N/mm^2]

$f_{v,k} =$ 2.5 [N/mm^2]

- de calcul:

$$k_{mod} = \frac{k_{modgk} \times 1{,}35 \times g_k + k_{modsk} \times 1{,}5 \times s_k + k_{modwk} \times 1{,}05 \times w_k}{1{,}35 \times g_k + 1{,}5 \times s_k + 1{,}05 \times w_k}$$

$f_{m,d} =$ 15 [N/mm^2]	$k_{mod,\,gk} =$ 0.6		
$f_{c,0,d} =$ 13 [N/mm^2]	$k_{mod,\,sk} =$ 0.9		
$f_{c,90,d} =$ 3 [N/mm^2]	$\gamma_m =$ 1.3	(cf. EC 5)	
$f_{v,d} =$ 2 [N/mm^2]	$k_{mod,\,wk} =$ 0.9		

$k_{mod} =$ 0.814

2.4.3) Modul de elasticitate:

$E_{0,m}$ = 11 [kN/mm^2]
$E_{0,05}$ = 7.4 [kN/mm^2]
$E_{90,m}$ = 0.37 [kN/mm^2]

2.4.4) Caracteristici sectionale:

W = 562.500 [cm^3]
I = 4218.750 [cm^4]
A = 225.000 [cm^2]

$$W = \frac{h^2 \times b}{6} \qquad I = \frac{b \times h^3}{12} \qquad A = b \times h$$

2.4.5) Verificare flambaj si compresiune:

λ_{rel} = 0.78 [-]
intervine flambajul

σ_{crt} = 34200.49 [kN/m^2]

λ = 46.19 [-]
λ<120- verifica

$\sigma_{c,0,d}$ = 1543.72 [kN/m^2]

k_c = 0.89 [-]

k = 0.84 [-]

$$\lambda_{rel} = \sqrt{\frac{f_{c.0.k}}{\sigma_{c.crit}}}$$
$$\sigma_{crit} = \frac{\pi^2 \times E_{0.05}}{\lambda^2}$$
$$\lambda = \frac{l_f}{\sqrt{I/A}}$$
$$\sigma_{c.0.d} = (\gamma_g \times F_g + \gamma_s \times F_s + \gamma_w \times F_w)/A$$
$$k_c = 1/(k + \sqrt{(k^2 - \lambda_{rel}^2)})$$ -coef. ce tine seama de flambaj
$$k = 0,5 \times (1 + \beta_c(\lambda_{rel} - 0,5) + \lambda_{rel}^2$$

$\beta_c = 0,2$ - coef. ce tine seama de imperfectiuni
- pentru lemn masiv

σ c,0,d / (k c* f c,0,d) ≤ 1 **VERIFICA**

2.5) Verificarea talpilor:

- dimensiuni:			
	b =	15	[cm]
	h =	15	[cm]
	l =	50	[cm]
- clasa de rezistenta a lemnului:		D70	

-verificare la compresiune (perpendicular pe fibre);

2.5.1) Incarcari:
- incarcari de calcul distribuite de pop:

♦ permanente:
$g^{\perp}_k = g_{k,pop}$
$g^{\perp}_k =$ 7.36 [kN]

♦ din zapada:
$s^{\perp}_k = s_{k,pop}$
$s^{\perp}_k =$ 13.97 [kN]

♦ utila:
$w(z)_k^{\perp} = w(z)_{k,pop}$
$w(z)_k^{\perp} =$ 3.67 [kN]

2.5.2) Rezistentele lemnului:

- caracteristice:

$f_{m,k} =$ 70 [N/mm^2]
$f_{c,0,k} =$ 34 [N/mm^2]
$f_{c,90,k} =$ 13.5 [N/mm^2]
$f_{v,k} =$ 6 [N/mm^2]

- de calcul:

$$k_{mod} = \frac{k_{mod.gk} \times g_{k.}^{-} \times 1{,}35 + k_{mod.sk} \times s_{k.}^{-} \times 1{,}5 + 1{,}05 \times U_{k}^{-} \times k_{mod.gk}}{1{,}35 \times g_{k.y}^{-} + 1{,}5 \times s_{k.y}^{-} + 1{,}05 \times U_{k}^{-}}$$

$f_{m,d} =$ 44 [N/mm^2]
$f_{c,0,d} =$ 21 [N/mm^2]
$f_{c,90,d} =$ 8 [N/mm^2]
$f_{v,d} =$ 4 [N/mm^2]

$k_{mod,\,gk} =$ 0.6
$k_{mod,\,sk} =$ 0.9
$\gamma_m =$ 1.3 (cf. EC 5)
$k_{mod,\,uk} =$ 1.1

$k_{mod} =$ 0.814

2.5.3) Modul de elasticitate:

$E_{0,m} =$ 20 [kN/mm^2]
$E_{0,05} =$ 16.8 [kN/mm^2]
$E_{90,m} =$ 1.33 [kN/mm^2]

2.5.4) Caracteristici sectionale:

W = 6250.000 [cm^3]
I = 156250.000 [cm^4]
A = 750.000 [cm^2]

$$W = \frac{l^2 \times b}{6} \qquad I = \frac{b \times l^3}{12} \qquad A = b \times l$$

2.5.5) Verificare compresiune:

$\sigma_{c,0,d} =$ 1543.72 [kN/m^2]

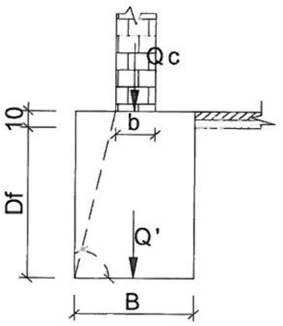
$$\sigma_{c.0.d} = (\gamma_g \times F_g + \gamma_s \times F_s + \gamma_w \times F_w)/A$$

$k_{c,90} = 1$ - din EC 5

$\sigma_{c,0,d} \leq k_{c,90} * f_{c,90,d}$ **VERIFICA**

VERIFICAREA FUNDATIILOR

VERIFICAREA FUNDATILOR CONTINUE



$g_{pl.} := 3\frac{kN}{m^2}$ - greutatea planseu

$q_{utila} := 1.5\frac{kN}{m^2}$

$A_{placa} := 16.25m^2 = 16.25m^2$ - aria aferenta

$Q_{c.1} := \left(0.5m\cdot 5.1m\cdot 20\frac{kN}{m^3}\right)\cdot 7.5m = 382.5kN$ - greutatea zid

$Q_{c.placa} := 1A_{placa}\cdot g_{pl.} = 48.75kN$

$Q_{c.sarpanta} := 2\frac{kN}{m^2}\cdot 18.8m^2$

$Q_{c.utila} := 1\cdot q_{utila}\cdot A_{placa} = 24.375kN$

$Q_{c.zapada} := 1.5\frac{kN}{m^2}\cdot 18.8m^2$

*incarcarea transmisa fundatiei continue

$Q_c := 1.35\left(Q_{c.1} + Q_{c.placa} + Q_{c.sarpanta}\right) + 1.5Q_{c.utila} + 1.05Q_{c.zapada} = 699.12kN$

$D_f := 1.2m$

$B := 0.6m$

$p_{conv} := 280\frac{kN}{m^2}$

$k_1 := 0.05$ $B_. := 0.6$ $p_{conv..} := 280$

$k_2 := 2.00$ $D_{f..} := 1.2$

$C_B := p_{conv..}\cdot k_1\cdot(B_. - 1) = -5.6$

$C_D := p_{conv..}\cdot\frac{D_{f..} - 2}{4} = -56$

$$p_{conv.cor.} := p_{conv} + \left(C_B + C_D\right) \cdot \frac{kN}{m^2} = 218.4 \frac{kN}{m^2}$$

Calculul presiunilor efective la talpa fundatiei

$$G_f := B \cdot \left(D_f\right) \cdot 25 \frac{kN}{m^3} = 18 \cdot \frac{kN}{m}$$

$$p_{ef.} := \frac{\frac{Q_c}{7.5m} + G_f}{B} = 185.36 \frac{kN}{m^2} \qquad < \qquad p_{conv.cor.} = 218 \cdot \frac{kN}{m^2}$$

DIMENSIONARE GRINDA CADRU

1.CALCULUL ARMATURILOR LONGITUDINALE

a.Calculul armaturilor la partea inferioara

$M_{Ed.camp} := 85.68 kN\cdot m$ *momentul incovoietor in fibra inferioara

$b := 0.30 m$ *latimea sectiuni transversale

$h := 0.45 m$ *inaltimea sectiunii transversale

$c := 0.030 m$ *stratul de acoperire cu beton a armaturilor longitudinale

$f_{ck} := 16 \frac{N}{mm^2}$

$\gamma_c := 1.2$

$f_{cd} := \frac{f_{ck}}{\gamma_c} = 13.333 \frac{N}{mm^2}$ *rezistenta de calcul a betonului

$f_{yk} := 345 \frac{N}{mm^2}$

$\gamma_s := 1.15$

$f_{yd} := \frac{f_{yk}}{\gamma_s} = 300 \frac{N}{mm^2}$ *rezistenta de calcul a otelului

$a_s := \frac{20mm}{2} + c = 0.04m$ *distanta din centrul armaturii la marginea sectiunii

$d := h - a_s = 0.41m$ *inaltimea utila a sectiunii

$h_a := d - a_s = 0.37m$ *distranta dintre armatura superioara si cea inferioara

$A_{sc} := \frac{M_{Ed.camp}}{f_{yd} \cdot h_a} = 7.72 cm^2$ *aria inferioara necesara

se alege => 3x $A_{ef} := 3 \cdot 3.14 cm^2 = 9.42 cm^2$

b.Calculul armaturilor la partea superioara

armatura din partea stanga

m *valoare relativa a momentului incovoietor

$M_{Ed.sup.st} := 55.93 kN\cdot m$ *momentul incovoietor la partea superioara

$$m_{st} := \frac{M_{Ed.sup.st} - A_{sc} \cdot f_{yd} \cdot h_a}{b \cdot d^2 \cdot f_{cd}} = -0.04$$

$m_{st} > C$ ==> $\xi_{st} := 1 - \sqrt{1 - 2 \cdot m_{st}}$

$\xi_{st} = -0.04$ $\xi < 0.2$ ==> $x := \xi_{st} \cdot d$

$x = -18 \cdot mm$ *respecta conditia a3 ,tabel 1 $x \le 2 \cdot a_s$ $2 \cdot a_s = 80 \cdot mm$

$$A_{ss.st} := \frac{M_{Ed.sup.st}}{f_{yd} \cdot h_a}$$ $A_{ss.st} = 5.039\,cm^2$

se alege => 3 x $A_{ef.st} := 3 \cdot 3.14cm^2 = 9.42cm^2$

armatura din partea dreapta

$M_{Ed.sup.dr} := 55.93kN \cdot m$ *momentul incovoietor la partea superioara

$$m_{dr} := \frac{M_{Ed.sup.dr} - A_{sc} \cdot f_{yd} \cdot h_a}{b \cdot d^2 \cdot f_{cd}} = -0.04$$

$m_{dr} > C$ ==> $\xi_{dr} := 1 - \sqrt{1 - 2 \cdot m_{dr}}$ $\xi_{dr} = -0.04$

$\xi_{dr} < 0.2$ ==> $x_{dr} := \xi_{dr} \cdot d$

$x_{dr} = -18 \cdot mm$ *respecta conditia a3 ,tabel 1 $x \le 2 \cdot a_s$ $2 \cdot a_s = 80 \cdot mm$

$$A_{ss.dr} := \frac{M_{Ed.sup.dr}}{f_{yd} \cdot h_a}$$ $A_{ss.dr} = 5.04\,cm^2$

se alege => 3x $A_{ef.dr} := 3 \cdot 3.14cm^2 = 9.42cm^2$

DIMENSIONARE STALP

CALCULUL ARMATURILOR LONGITUDINALE

Valorile eforturilor sectionale:
Momentele incovoietoare si fortele axiale corespunzatoare sectiunilor alaturate din combinatiile de seism

$N_{Ed1} := 110.55kN$

$M_{Ed1} := 5 \cdot kN \cdot m$ - *eforturile efective din stalp*

$h_{st} := 0.35m$

$b_{st} := 0.35m$ - *dimensiuniile sectiunii transversale ale stalpului*

$a_s := 0.03m$ - *acoperirea cu beton*

$d := 0.32m$ - *inaltimea efectiva,utila a sectiunii*

$h_a := 0.29m$ - *distanta intre armaturi*

$A_c := b_{st} \cdot h_{st} = 0.122m^2$ - *aria sectiunii transversale a stalpului*

$f_{ck} := 16 \frac{N}{mm^2}$

$\gamma_c := 1.2$

$f_{cd} := \frac{f_{ck}}{\gamma_c} = 13.333 \frac{N}{mm^2}$ *rezistenta de calcul a betonului

$f_{yk} := 345 \frac{N}{mm^2}$

$\gamma_s := 1.15$

$f_{yd} := \frac{f_{yk}}{\gamma_s} = 300 \frac{N}{mm^2}$ *rezistenta de calcul a otelului

$\gamma_{Rd} := 1.3$

$A_{s.tot.min} := 0.001 \cdot b_{st} \cdot h_{st} = 1.225cm^2$ -aria totala minima

Definitivarea dimensiunilor sectiunii de beton, se face pe baza conditiei ca stalpii sa lucreze in cazul I de compresiune excentrica dreapta.

Asigurarea conditiei de ductilitate locala

$v_d := \frac{N_{Ed1}}{A_c \cdot f_{cd}}$ $v_d = 0.068$ -valoarea normalizata a fortei axiale

$v_d \leq 0.40$ (H ductility) => conditia este indeplinita; in consecinta dimensiunile stalpului raman aceleasi.

Calculul stalpului la compresiun excentrica dreapta:

$x := \frac{N_{Ed1}}{b_{st} \cdot f_{cd}}$ $x = 0.024m$ ==> $x < 2 \cdot a_s$ $2 \cdot a_s = 0.06m$

$e_a := max\left(20mm, \frac{h_{st}}{30}\right) = 0.02m$ *-excentricitate aditionala*

$\eta_{cr} := 32$ *-coeficientul tine seama de efectele de ordinul II*

$\eta := \frac{1}{1 - \frac{1}{\eta_{cr}}} = 1.032$

$M_{Edc} := \eta \cdot (M_{Ed1} + e_a \cdot N_{Ed1}) = 7.444 kN \cdot m$ -momentele incovoietoare din stalp, tinand seama de ef.de ordinul II

$M_{d.stelat} = \gamma_{Rd} \cdot M_{Edc} \frac{\Sigma M_{Rb}}{\Sigma M_{Edb}}$

$A_{gr.i} := 9.42cm^2$ $A_{gr.s} := 9.42cm^2$ *ariile de armatura din grinzile marginale transversale

$h_{jw} := 0.32m$ *inaltimea utila a grinzii

$M_{Rb.gr.i} := A_{gr.i} \cdot f_{yd} \cdot h_{jw} = 90.432kN \cdot m$

$M_{Rb.gr.s} := A_{gr.s} \cdot f_{yd} \cdot h_{jw} = 90.432kN \cdot m$ *momentele incovoietoare capabile din grinzi

$M_{Edb.i} := 85.68kN \cdot m$

$M_{Edb.s} := 55.93kN \cdot m$ *momentele incovoietoare efective din grinzi

$\frac{M_{Rb.gr.i} + M_{Rb.gr.s}}{M_{Edb.i} + M_{Edb.s}} = 1.277$

$M_{Rd.stelat} := \gamma_{Rd} \cdot M_{Edc} \cdot 1.277 = 12.357kN \cdot m$

$\mu := \frac{M_{Rd.stelat}}{b_{st} \cdot h_{st}^2 \cdot f_{cd}} = 0.022$ $v := \frac{N_{Ed1}}{A_c \cdot f_{cd}} = 0.068$

$\frac{a_s}{h_{st}} = 0.086$ $\omega_{tot} := 0.25$

Dimensionarea armaturilor

$A_{s.tot} := \omega_{tot} \cdot b_{st} \cdot h_{st} \cdot \frac{f_{cd}}{f_{yd}} = 13.611 cm^2$ 6 x $A_{ef} := 15.26cm^2$

$\rho := \frac{A_{ef}}{b_{st} \cdot h_{st}} = 0.012$ >0.008 ok

Dimensionarea la forta taietoare

$V_{Ed} \le V_{Rdc}$

$k := 1 + \sqrt{\frac{200mm}{d}} = 1.791$ <2

$A_{sl} := 8 \cdot 1.54cm^2 = 12.32cm^2$ *aria armaturii longitudinale

$b_w := 0.25m$ -latimea minima a sectiunii in zona intinsa

$\rho_l := \frac{A_{sl}}{b_w \cdot d} = 0.02$ -coeficient de armare longitudinala

$\sigma_{cp} := \frac{N_{Ed1}}{A_c} = 0.9 \frac{N}{mm^2}$ -efort unitar mediu

$C_{rdc} := \frac{0.18}{\gamma_c} = 0.15$ -din anexele nationale,am considerat valorile recomandate

$k_1 := 0.15$

$v_{min} := 0.035 k^{\frac{3}{2}} \cdot f_{ck}^{\frac{1}{2}}$ $v_{min.} := 0.323 \frac{N}{mm^2}$

$$V_{Rdc} := \left[C_{rdc} \cdot k \cdot \left(\left(100 \rho_l \cdot f_{ck}\right)\right)^{\frac{1}{3}} + k_1 \cdot \sigma_{cp}\right] \cdot b_w \cdot d =$$

$$\left[0.15 \cdot 1.791 \cdot \left[\left[100 \cdot 0.015 \left(1.6 \times 10^4\right)\right]\right]^{\frac{1}{3}} + 0.15 \left(4.93 \times 10^3\right)\right] \cdot 0.25 \cdot 0.32 = 59.78$$

$V_{Rdc.} := 60kN$

$V_{Rdc.min} := \left(v_{min.} + k_1 \cdot \sigma_{cp}\right) \cdot b_w \cdot d = 36.669kN$

Valoarea fortelor taietoare de proiectare

$M_{Rc} := \frac{N_{Ed1} \cdot \left(h_{st} - x\right)}{2} + A_{ef} \cdot f_{yd} \cdot h_a = 150.8kN \cdot m$

$M_{db1} := \gamma_{Rd} \cdot M_{Rc} \cdot 1 = 196.038kN \cdot m$

$M_{db2} := \gamma_{Rd} \cdot M_{Rc} \cdot 1 = 196.038kN \cdot m$

$l_{cl} := 3m$ -lungimea de calcul a stalpului

Calculul la forta taietoare

$V_{E.dc} := \frac{M_{db1} + M_{db2}}{l_{cl}} = 130.692kN$ -forta taietoare de proiecare

$V_{Rdc.} = 60 \cdot kN$ ==> $V_{Edc} > V_{Rdc}$

Limitarea nivelului de solicitare la forte taietoare

Deoarece stalpul pe inaltimea lui are aceiasi sectiune transversala verificarea de mai jos se va face doar pt cea mai mare valoare a lui Q

$f \;\; \cdot \;\; 0.05 \; N \;\; 050 \; kN$ *rezistenta la intindere a betonului C25/30 cu valoare de calcul

$Q := \frac{V_{E.dc}}{b_{st} \cdot d \cdot f_{ctd}} = 1.228$ <2 gradul de solicitare a stalpului la forta taietoare

==> dimens. stalpului raman neschimbate

$l_{cr} := \max\left(h_{st}, \frac{l_{cl}}{6}, 450mm\right) = 0.5m$ ==> etrieri cu diametrul de ϕ =8 mm

Cantitaea minima de armatura de taiere este stabilita de conditia:

$A_{sw} := 50.30mm^2$ A_{sw} -aria armaturii de taiere dispusa la distanta s

$\rho_{w.min} := \left(\frac{0.08\sqrt{f_{ck}}}{f_{yk}}\right)$ $d_{bL} := 22mm$ -diametru maxim al barelor longit

$\rho_{w.min.} := 9.275 \times 10^{-4}$

s <(b_o/2;175;8d_{bL})=(320/2=160;175;160)=100 mm

$s_{1.} := 100mm$ -pt zonele critice

s <(200;15d_{bL})=(200;300)=200 mm

$s_{2.} := 150mm$ -pt zonele necritice

$\rho_{w1} := \frac{4 \cdot A_{sw}}{s_{1.} \cdot b_w} = 8.048 \times 10^{-3}$ -coeficient de armare transversala zona 1

$\rho_{w2} := \frac{4 \cdot A_{sw}}{s_{2.} \cdot b_w} = 5.365 \times 10^{-3}$ zona 2

ρ_w este cel putin 0.0035 pt zona critica a stalpilor de la baza lor,la primul nivel

ρ_w este cel putin 0.0025 pt restul zonelor critice

DIMENSIONAREA ARMATURII TRANSVERSALE

$\nu := \frac{N_{Ed1}}{A_c \cdot f_{cd}} = 0.068$

$m_{at} := 1 + 0.5\nu = 1.034$ -coeficientul conditiilor de lucru a armaturilor solicitate la fortecare

$f_{ywd} := m_{at} \cdot f_{yd} = 310.153 \frac{N}{mm^2}$ -valoarea de proiectare a a rezistentei la curgerea otelului

$f_{ctd} = 0.95 \frac{N}{mm^2}$

$m_t := 0.97$ -deoarece Qbarat<2

$f_{ctd.red} := m_t \cdot f_{ctd} = 0.921 \frac{N}{mm^2}$

$A_{al} := A_{ef} = 15.26cm^2$

Verificarea etrierilor

Pentru zona critica

$n_e := 3 \qquad A_{sw} = 0.503\,cm^2 \qquad s_{1.} = 0.1\,m$

$$p := \frac{A_{al}}{b_{st} \cdot d} \cdot 100 = 1.363$$

$$q_e := \frac{n_e \cdot A_{sw} \cdot f_{ywd}}{s_{1.}} = 468.02 \frac{N}{mm}$$

$$s_i := \sqrt{\frac{b_{st} \cdot d^2 \cdot \sqrt{p} \cdot m_t \cdot f_{ctd}}{q_e}} = 0.287m$$

$s_i = 0.287m \qquad 0.5 \cdot d = 0.16m \qquad 2.5 \cdot d = 0.8m$ ==> 0.5d<s.i<2.5d

Determinarea fortei taietoare preluata de etrieri si beton

$$Q_{eb} := 2 \cdot \sqrt{b_{st} \cdot d^2 \cdot \sqrt{p} \cdot m_t \cdot f_{ctd} \cdot q_e} - n_e \cdot A_{sw} \cdot f_{ywd} = 221.843kN$$

$Q_{eb} = 221.843kN$

$Q_{cap} := Q_{eb}$ ==> $Q_{cap} \geq V_{E.dc}$

$V_{E.dc} = 130.692kN$

Inafara zonelor critice

$n_e = 3$

$A_{sw} = 0.503\,cm^2 \qquad s_{2.} = 0.15m$

$$f_{ywd} = 310.153 \frac{N}{mm^2}$$

$$q_{e.} := \frac{n_e \cdot A_{sw} \cdot f_{ywd}}{s_{2.}} = 312.013 \frac{N}{mm}$$

$A_{al.} := A_{ef} = 15.26\,cm^2$

$$s_{i.} := \sqrt{\frac{b_{st} \cdot d^2 \cdot \sqrt{p} \cdot m_t \cdot f_{ctd}}{q_{e.}}} = 0.352m$$

$$p_{.} := \frac{A_{al.}}{b_{st} \cdot d} \cdot 100 = 1.363$$

$s_{i.} = 0.352m \qquad 0.5 \cdot d = 0.16m \qquad 2.5 \cdot d = 0.8m$ ==> 0.5d<s.i<2.5d

Determinarea fortei taietoare preluata de etrieri si beton

$$Q_{eb.} := 2 \cdot \sqrt{b_{st} \cdot d^2 \cdot \sqrt{p_{.}} \cdot m_t \cdot f_{ctd} \cdot q_{e.}} - n_e \cdot A_{sw} \cdot f_{ywd} = 172.545kN$$

$Q_{cap.} := Q_{eb} \qquad V_{E.dc} = 130.692kN$ ==> $Q_{cap} \geq V_{E.dc}$

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