

BREVIAR DE CALCUL

Încărcări

Gruparea încărcărilor a fost considerată conform normativului „Bazele proiectării structurilor în construcții” indicativ CR0-2005.

În afara încărcărilor din greutatea proprie a structurii, au mai fost luate în calcul următoarele încărcări:

* **Variabile**

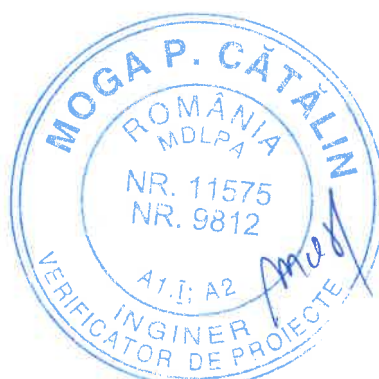
➤ Încărcarea utilă:

- Camere :

1.50 kN/m²

➤ Vant:

0.40 kN/m²



* **Încărcări din zăpadă:**

Conform CR-1-1-3-2012 valoarea caracteristică a încărcării cu zăpadă pe acoperis

$$S_k = \mu_i C_e C_t S_{0k}; \alpha = 0^\circ$$

$$\mu_1 = 0,80; C_e = 1,0; C_t = 1,0; S_{0k} = 1,50 \text{ kN/mp}$$

$$s_1 = 1,20 \text{ kN/mp}$$

* **Încărcări la nivelul acoperisului terasă**

➤ Hidroizolație - membrana ventilată:

0.05 kN/m²

➤ Termoizolație rigidă min. 10 cm:

0.07 kN/m²

➤ Beton de pantă 5 cm:

1.20 kN/m²

➤ Planșeu din beton armat h=17cm :

4.25 kN/m²

TOTAL: 5.57 kN/m²

* **Încărcare din greutatea peretilor exteriori din BCA 25cm grosime, tencuit pe ambele fețe și termoizolat**

➤ Perete BCA 25 cm :

2.25 kN/m²

➤ Tencuială 2x2cm :

0.84 kN/m²

➤ Termoizolație 5cm :

0.02 kN/m²

TOTAL: 3.11 kN/m²

* **Încărcare din greutatea fundațiilor:**

➤ Fundație din beton 50 cm lățime :

12.50 kN/m²

➤ Elevație din beton armat 25 cm lățime :

6.25 kN/m²

Verificare fundatie centrala termica

S_{max} aferent = 2.56 m²

-acoperis terasa: 5.57 kN/m² x 2.56 m² = 14.26 kN

-perete parter: 3.11 kN/m² x 2.80 m x 1.00 m = 8.70 kN

-fundatie: 12.50 kN/m² x 0.50m x 1.00m = 6.25 kN

-elevatie.: 6.25 kN/m² x 0.85 m x 1.00m = 5.31 kN

TOTAL: 34.52 kN

-incarcare din zapada: 1.20 kN/m² x 2.56 m² = 3.07 kN

TOTAL: 3.07 kN

Incarcari de calcul:

34.52 kN x 1.35 + 3.07 kN x 1.5 = 51.20 kN

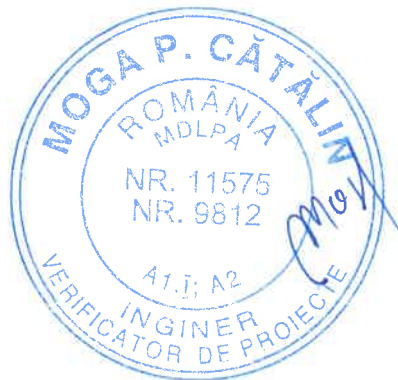
$p_{conv} = 300$ kPa

$C_B = p_{conv} \cdot k_1 \cdot (B-1) = -7.50$

$C_D = p_{conv} \cdot (D_f-2)/4 = -52.50$

$p_{conv} = 240$ kPa

$p_{ef} = 51.20$ kN / (0.50 m x 1.00 m) = 102.40 kPa < 1.20 x $p_{conv} = 288.00$ kPa



Întocmit:

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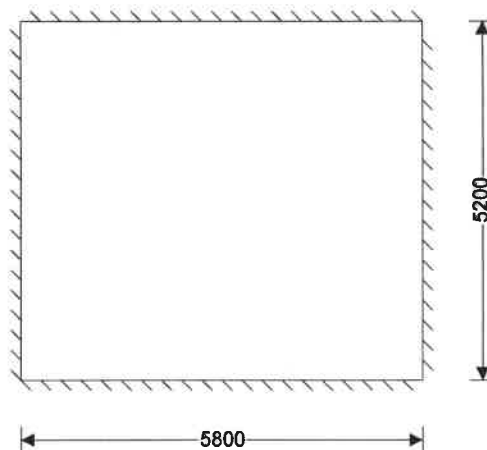
CALCUL PLANSEU B.A. CENTRALA TERMICA

Calculul a fost realizat cu programul Tekla Tedds.

Tedds calculation version 1.0.22

Design summary

Description	Unit	Provided	Required	Utilisation	Result
Short span					
Reinf. at midspan	mm ² /m	524	289	0.553	PASS
Bar spacing at midspan	mm	150	300	0.500	PASS
Shear at discont. supp	kN/m	70.7	24.2	0.343	PASS
Deflection ratio		37.14	39.31	0.945	PASS
Long span					
Reinf. at midspan	mm ² /m	524	263	0.502	PASS
Bar spacing at midspan	mm	150	300	0.500	PASS
Shear at discont. supp	kN/m	67.3	24.2	0.360	PASS
Cover					
Min cover bottom	mm	25	20	0.800	PASS

**Slab definition**

Slab reference name;

planseu CT

Type of slab;

Two way spanning with restrained edges

Overall slab depth;

h = 170 mm

Shorter effective span of panel;

l_x = 5200 mm

Longer effective span of panel;

l_y = 5800 mm

Support conditions;

Four edges discontinuous

;

Bottom outer layer of reinforcement;

Short span direction**Loading**

Characteristic permanent action;

G_k = 5.6 kN/m²

Characteristic variable action;	$Q_k = 1.2 \text{ kN/m}^2$
Partial factor for permanent action;	$\gamma_G = 1.35$
Partial factor for variable action;	$\gamma_Q = 1.50$
Quasi-permanent value of variable action;	$\psi_2 = 0.30$
Design ultimate load;	$q = \gamma_G \times G_k + \gamma_Q \times Q_k = 9.3 \text{ kN/m}^2$
Quasi-permanent load;	$q_{SLS} = 1.0 \times G_k + \psi_2 \times Q_k = 5.9 \text{ kN/m}^2$
Concrete properties	
Concrete strength class;	C20/25
Characteristic cylinder strength;	$f_{ck} = 20 \text{ N/mm}^2$
Partial factor (Table 2.1N);	$\gamma_C = 1.50$
Compressive strength factor (cl. 3.1.6);	$\alpha_{cc} = 1.00$
Design compressive strength (cl. 3.1.6);	$f_{cd} = 16.7 \text{ N/mm}^2$
Mean axial tensile strength (Table 3.1);	$f_{ctm} = 0.30 \text{ N/mm}^2 \times (f_{ck} / 1 \text{ N/mm}^2)^{2/3} = 2.6 \text{ N/mm}^2$
Maximum aggregate size;	$d_g = 20 \text{ mm}$
Effective strength factor – exp.3.21;	$\eta = 1.00$
Effect. compr. zone height factor – exp.3.19;	$\lambda = 0.80$
Ultimate strain - Table 3.1;	$\epsilon_{cu2} = 0.0035$
Shortening strain - Table 3.1;	$\epsilon_{cu3} = 0.0035$
	$K_1 = 0.44$
	$K_2 = 1.25 \times (0.6 + 0.0014/\epsilon_{cu2}) = 1.25$
Design value modulus of elasticity reinf – 3.2.7(4)	$E_s = 200000 \text{ N/mm}^2$

Reinforcement properties

Characteristic yield strength;	$f_{yk} = 500 \text{ N/mm}^2$
Partial factor (Table 2.1N);	$\gamma_S = 1.15$
Design yield strength (fig. 3.8);	$f_{yd} = f_{yk} / \gamma_S = 434.8 \text{ N/mm}^2$

Concrete cover to reinforcement

Nominal cover to outer bottom reinforcement;	$c_{nom_b} = 25 \text{ mm}$
Fire resistance period to bottom of slab;	$R_{btm} = 90 \text{ min}$
Axial distance to bottom reinf (Table 5.8);	$a_{fi_b} = 15 \text{ mm}$
Min. btm cover requirement with regard to bond;	$c_{min,b_b} = 10 \text{ mm}$
Reinforcement fabrication;	Not subject to QA system
Cover allowance for deviation;	$\Delta C_{dev} = 10 \text{ mm}$
Min. required nominal cover to bottom reinf;	$c_{nom_b_min} = 20.0 \text{ mm}$

PASS - There is sufficient cover to the bottom reinforcement

Reinforcement design at midspan in short span direction (cl.6.1)

Bending moment coefficient;	$\beta_{sx_p} = 0.0664$
Design bending moment;	$M_{x_p} = \beta_{sx_p} \times q \times l_x^2 = 16.7 \text{ kNm/m}$
Reinforcement provided;	10 mm dia. bars at 150 mm centres
Area provided;	$A_{sx_p} = 524 \text{ mm}^2/\text{m}$
Effective depth to tension reinforcement;	$d_{x_p} = h - c_{nom_b} - \phi_{x_p} / 2 = 140.0 \text{ mm}$
K factor;	$K = M_{x_p} / (b \times d_{x_p}^2 \times f_{ck}) = 0.034$
Redistribution ratio;	$\delta = 1.0$
K' factor;	$K' = (2 \times \eta \times \alpha_{cc} / \gamma_C) \times (1 - \lambda \times (\delta - K_1) / (2 \times K_2)) \times (\lambda \times (\delta - K_1) / (2 \times K_2)) = 0.196$

$K < K'$ - Compression reinforcement is not required

Lever arm;	$z = \min(0.95 \times d_{x_p}, d_{x_p}/2 \times [1 + (1 - 2 \times K / (\eta \times \alpha_{cc} / \gamma_c))^{0.5}])$ = 133.0 mm
Area of reinforcement required for bending;	$A_{s_{x_p_m}} = M_{x_p} / (f_{yd} \times z) = \mathbf{289 \text{ mm}^2/m}$
Minimum area of reinforcement required; 187 mm²/m	$A_{s_{x_p_{min}}} = \max(0.26 \times (f_{ctm}/f_{yk}) \times b \times d_{x_p}, 0.0013 \times b \times d_{x_p}) =$
Area of reinforcement required;	$A_{s_{x_p_{req}}} = \max(A_{s_{x_p_m}}, A_{s_{x_p_{min}}}) = \mathbf{289 \text{ mm}^2/m}$

PASS - Area of reinforcement provided exceeds area required

Check reinforcement spacing

Reinforcement service stress; N/mm ²	$\sigma_{s_{x_p}} = (f_{yk} / \gamma_s) \times \min((A_{s_{x_p_m}}/A_{s_{x_p}}), 1.0) \times q_{SLS} / q = \mathbf{152.9}$
Maximum allowable spacing (Table 7.3N);	$s_{max_{x_p}} = \mathbf{300 \text{ mm}}$
Actual bar spacing;	$s_{x_p} = \mathbf{150 \text{ mm}}$

PASS - The reinforcement spacing is acceptable

Reinforcement design at midspan in long span direction (cl.6.1)

Bending moment coefficient;	$\beta_{s_{y_p}} = \mathbf{0.0560}$
Design bending moment;	$M_{y_p} = \beta_{s_{y_p}} \times q \times l_x^2 = \mathbf{14.1 \text{ kNm/m}}$
Reinforcement provided;	10 mm dia. bars at 150 mm centres
Area provided;	$A_{s_{y_p}} = \mathbf{524 \text{ mm}^2/m}$
Effective depth to tension reinforcement;	$d_{y_p} = h - c_{nom_b} - \phi_{x_p} - \phi_{y_p} / 2 = \mathbf{130.0 \text{ mm}}$
K factor;	$K = M_{y_p} / (b \times d_{y_p}^2 \times f_{ck}) = \mathbf{0.033}$
Redistribution ratio;	$\delta = \mathbf{1.0}$
K' factor;	$K' = (2 \times \eta \times \alpha_{cc} / \gamma_c) \times (1 - \lambda \times (\delta - K_1) / (2 \times K_2)) \times (\lambda \times (\delta - K_1) / (2 \times K_2)) = \mathbf{0.196}$

K < K' - Compression reinforcement is not required

Lever arm;	$z = \min(0.95 \times d_{y_p}, d_{y_p}/2 \times [1 + (1 - 2 \times K / (\eta \times \alpha_{cc} / \gamma_c))^{0.5}])$ = 123.5 mm
Area of reinforcement required for bending;	$A_{s_{y_p_m}} = M_{y_p} / (f_{yd} \times z) = \mathbf{263 \text{ mm}^2/m}$
Minimum area of reinforcement required; 173 mm²/m	$A_{s_{y_p_{min}}} = \max(0.26 \times (f_{ctm}/f_{yk}) \times b \times d_{y_p}, 0.0013 \times b \times d_{y_p}) =$
Area of reinforcement required;	$A_{s_{y_p_{req}}} = \max(A_{s_{y_p_m}}, A_{s_{y_p_{min}}}) = \mathbf{263 \text{ mm}^2/m}$

PASS - Area of reinforcement provided exceeds area required

Check reinforcement spacing

Reinforcement service stress; N/mm ²	$\sigma_{s_{y_p}} = (f_{yk} / \gamma_s) \times \min((A_{s_{y_p_m}}/A_{s_{y_p}}), 1.0) \times q_{SLS} / q = \mathbf{138.9}$
Maximum allowable spacing (Table 7.3N);	$s_{max_{y_p}} = \mathbf{300 \text{ mm}}$
Actual bar spacing;	$s_{y_p} = \mathbf{150 \text{ mm}}$

PASS - The reinforcement spacing is acceptable

Shear capacity check at short span discontinuous support

Shear force;	$V_{x_d} = q \times l_x / 2 = \mathbf{24.2; \text{ kN/m;}}$
Reinforcement provided;	10 mm dia. bars at 150 mm centres
Area provided;	$A_{s_{x_d}} = \mathbf{524 \text{ mm}^2/m}$
Effective depth;	$d_{x_d} = h - c_{nom_b} - \phi_{x_d} / 2 = \mathbf{140.0; \text{ mm}}$
Effective depth factor;	$k = \min(2.0, 1 + (200 \text{ mm} / d_{x_d})^{0.5}) = \mathbf{2.000}$
Reinforcement ratio;	$\rho_l = \min(0.02, A_{s_{x_d}} / (b \times d_{x_d})) = \mathbf{0.0037}$
Minimum shear resistance;	$V_{Rd,c_{min}} = 0.035 \text{ N/mm}^2 \times k^{1.5} \times (f_{ck} / 1 \text{ N/mm}^2)^{0.5} \times b \times d_{x_d}$ $V_{Rd,c_{min}} = \mathbf{69.3 \text{ kN/m}}$

Shear resistance constant (cl. 6.2.2);

$$CR_{d,c} = 0.18 \text{ N/mm}^2 / g_c = 0.12 \text{ N/mm}^2$$

Shear resistance;

$$V_{Rd,c_x_d} = \max(V_{Rd,c_{min}}, CR_{d,c} \times k \times (100 \times \rho_l \times (f_{ck}/1 \text{ N/mm}^2))^{0.333} \times b \times d_{x_d}) = 70.7 \text{ kN/m}$$

PASS - Shear capacity is adequate (0.343)
Shear capacity check at long span discontinuous support

Shear force;

$$V_{y_d} = q \times l_x / 2 = ;24.2; \text{ kN/m};$$

Reinforcement provided;

10 mm dia. bars at 150 mm centres

Area provided;

$$A_{sy_d} = 524 \text{ mm}^2/\text{m}$$

Effective depth;

$$d_{y_d} = h - c_{nom_b} - \phi_{x_p} - \phi_{y_d} / 2 = ;130.0; \text{ mm}$$

Effective depth factor;

$$k = \min(2.0, 1 + (200 \text{ mm} / d_{y_d})^{0.5}) = 2.000$$

Reinforcement ratio;

$$\rho_l = \min(0.02, A_{sy_d} / (b \times d_{y_d})) = 0.0040$$

Minimum shear resistance;

$$V_{Rd,c_{min}} = 0.035 \text{ N/mm}^2 \times k^{1.5} \times (f_{ck} / 1 \text{ N/mm}^2)^{0.5} \times b \times d_{y_d}$$

$$V_{Rd,c_{min}} = 64.3 \text{ kN/m}$$

Shear resistance constant (cl. 6.2.2);

$$CR_{d,c} = 0.18 \text{ N/mm}^2 / \gamma_c = 0.12 \text{ N/mm}^2$$

Shear resistance;

$$V_{Rd,c_y_d} = \max(V_{Rd,c_{min}}, CR_{d,c} \times k \times (100 \times \rho_l \times (f_{ck}/1 \text{ N/mm}^2))^{0.333} \times b \times d_{y_d}) =$$

$$67.3 \text{ kN/m}$$

PASS - Shear capacity is adequate (0.360)
Basic span-to-depth deflection ratio check (cl. 7.4.2)

Reference reinforcement ratio;

$$\rho_0 = (f_{ck} / 1 \text{ N/mm}^2)^{0.5} / 1000 = 0.0050$$

Required tension reinforcement ratio;

$$\rho = \max(0.0035, A_{sx_p_{req}} / (b \times d_{x_p})) = 0.0035$$

Required compression reinforcement ratio;

$$\rho' = A_{scx_p_{req}} / (b \times d_{x_p}) = 0.0000$$

Structural system factor (Table 7.4N);

$$K_\delta = 1.0$$

Basic limit span-to-depth ratio (Exp. 7.16);

$$\text{ratio}_{lim_x_{bas}} = K_\delta \times [11 + 1.5 \times (f_{ck}/1 \text{ N/mm}^2)^{0.5} \times \rho_0 / \rho + 3.2 \times (f_{ck}/1 \text{ N/mm}^2)^{0.5} \times (\rho_0 / \rho - 1)^{1.5}] = 26.20$$

Mod span-to-depth ratio limit;

$$\text{ratio}_{lim_x} = \min(1.5, (500 \text{ N/mm}^2 / f_{yk}) \times (A_{sx_p} / A_{sx_p_m})) \times \text{ratio}_{lim_x_{bas}} = 39.31$$

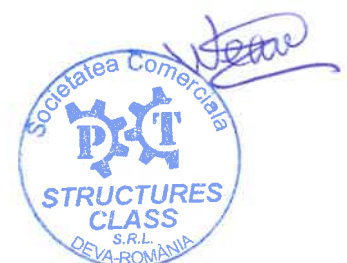
Actual span-to-eff. depth ratio;

$$\text{ratio}_{act_x} = l_x / d_{x_p} = 37.14$$

PASS - Actual span-to-effective depth ratio is acceptable

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BREVIAR DE CALCUL ELEMENTE SARPANTA

Sarpanta se executa din lemn de rasinoase , tratat pe suprafata, avand :

- clasa I de calitate pentru elementele intinse;
- clasa II de calitate pentru elementele comprimate sau incovoiate;
- clasa I de exploatare din punct de vedere al conditiilor de umiditate:

Verificarea elementelor se face pentru gruparea: permanenta + zapada;

Invelitoarea este din: **TIGLA METALICA**

Panta invelitorii : **15 °**

1) Evaluare incarcari:

a) incarcari permanente:

Denumire element	g_p^n [daN/m ²]	n	g_p^c [daN/m ²]
Invelitoare tigla metalica	10,0	1,35	13,5
Sipci	3,5	1,35	4,725
Capriori	12,0	1,35	16,2
Total	25,5	-	34,425

b) incarcare din zapada:

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

p_z^n - valoarea normata a incarcarii din zapada;

$$p_z^n = c_e \cdot c_{zi} \cdot g_z$$

$$p_z^n = 150 \text{ [daN/m}^2\text{]}$$

$$c_e = 0,8 \text{ - coef. de expunere pt. conditii normale de expunere; (p. 58)}$$

$$c_{zi} = 1,25 \text{ - coef. cu valoare maxima in varianta II; (tab 3.1 p.59)}$$

$$g_z = 150 \text{ [daN/m}^2\text{]} \text{ - greutatea stratului de baza pentru zona climatica; (tab 3.11 p.61)}$$

$$\text{- zona C : } 150 \text{ [daN/m}^2\text{]}$$

p_z^c - valoarea de calcul a incarcarii din zapada;

$$p_z^c = \gamma_F \cdot p_z^n$$

$$- \gamma_F \cdot (g_z) \geq 0,3 \cdot \gamma_a = 2,12$$

$$p_z^c = 317,25 \text{ [daN/m}^2\text{]}$$

$$\gamma_a = 2,2$$

$$g_p^n = 25,5$$

$$c_e = 0,8$$

$$g_z = 150$$

c) incarcarea utila:

$$p_u^n = 0 \text{ [daN]} \text{ - valoarea normata a incarcarii utile;}$$

$$p_u^c = n \cdot p_u^n \text{ - valoarea de calcul a incarcarii utile;}$$

$$n = 1,2 \text{ - coef de siguranta; (tab.57 p.39);}$$

$$p_u^c = 0 \text{ [daN]}$$

2) Dimensionarea elementelor componente ale sarpantei

2.1) Dimensionarea sipcilor:

- sectiune :		[cm]	5,00	3,00	
- distanta dintre sipci:	ds=	0,34	[m]		
- distanta dintre capriori:	dc=	0,80	[m]		sin α = 0,259
- unghiul invelitorii :	α =	15	[°]		cos α = 0,966

- verificare la incovoiere oblica;

a) Incarcari:

- incarcari de calcul distribuite pe sipca:

▶ pe directia verticala:

♦ permanente:

$$g_{p}^{c,s} = g_p^c * ds$$

$$g_{p}^{c,s} = 6,20 \text{ [daN/m]}$$

♦ din zapada:

$$g_{z}^{c,s} = p_z^c * ds * \cos\alpha$$

$$g_{z}^{c,s} = 104 \text{ [daN/m]}$$

$$g_p^c = 18,225 \text{ [daN/m}^2\text{]}$$

$$p_z^c = 317 \text{ [daN/m}^2\text{]}$$

$$g_p^n = 13,50 \text{ [daN/m}^2\text{]}$$

▶ descompuse pe cele 2 directii x-x si y-y:

♦ permanente:

$$g_{p,x}^{c,s} = g_p^{c,s} * \sin\alpha = 1,60 \text{ [daN/m]}$$

$$g_{p,y}^{c,s} = g_p^{c,s} * \cos\alpha = 5,99 \text{ [daN/m]}$$

♦ din zapada:

$$g_{z,x}^{c,s} = g_z^{c,s} * \sin\alpha = 26,95 \text{ [daN/m]}$$

$$g_{z,y}^{c,s} = g_z^{c,s} * \cos\alpha = 100,65 \text{ [daN/m]}$$

incarcari normate distribuite pe sipca:

▶ pe directia verticala:

♦ permanente:

$$g_p^{n,s} = g_p^n * ds = 4,59 \text{ [daN/m]}$$

♦ din zapada:

$$g_z^{n,s} = p_z^n * ds * \cos\alpha = 49,26 \text{ [daN/m]}$$

▶ descompuse pe cele 2 directii x-x si y-y:

♦ permanente:

$$g_{p,x}^{n,s} = g_p^{n,s} * \sin\alpha = 1,19 \text{ [daN/m]}$$

$$g_{p,y}^{n,s} = g_p^{n,s} * \cos\alpha = 4,43 \text{ [daN/m]}$$

♦ din zapada:

$$g_{z,x}^{n,s} = g_z^{n,s} * \sin\alpha = 12,74 \text{ [daN/m]}$$

$$g_{z,y}^{n,s} = g_z^{n,s} * \cos\alpha = 47,59 \text{ [daN/m]}$$

b) Verificarea de rezistenta:

$$+M_{ef}^x / M_r^x + -M_{ef}^y / M_r^y \leq 1$$

$$M_x^s = (g_{p,x}^{c,s} + g_{z,x}^{c,s}) * dc^2 / 8 = 228,45 \text{ [daN*cm]}$$

$$M_y^s = (g_{p,y}^{c,s} + g_{z,y}^{c,s}) * dc^2 / 8 = 853,06 \text{ [daN*cm]}$$

$$M_r = R_i^c * W_{calc} * m_{Ti}$$

$$R_i^c = (m_{ui} * m_{di} * R_i) / \gamma = 146,00 \text{ [daN/cm}^2\text{]} \quad (m_{ui} = \text{tab. 4.7, p96})$$

$m_{ui} = 1$ - coef de lucru, definit pe baza conditiilor de microclimat, in care sunt exploatate elemntele de constructie; (clasa I de exploatare);
 $m_{di} = 0,956$ - coef de lucru, stabilit in functie de durata de actiune a incarcarii si de tipul solicitarilor; (tab. 4.8, p96)
 $m_{d1} = 0,55$ - pt incarcari permanente;
 $m_{d2} = 1,00$ - pt incarcari din zapada;
 $m_d = (m_{d1} * g_p + m_{d2} * g_z) / (g_p + g_z)$ - medie ponderata;
 - ipoteza I : perman. + zapada;
 $\gamma = 1,1$ - coef partial de siguranta;
 $R_i = 168$ [daN/cm²] - rezistenta la incovoiere, lemn rasinoase cl. II;
 $m_{Ti} = 1,0$ - coeficient de tratare - lemn tratat pe suprafata;

$$W_x = W_y = h^3/6 = 20,83 \text{ [cm}^3\text{]}$$

$$I_x = I_y = h^4/12 = 52,08 \text{ [cm}^6\text{]}$$

$$M_r^x = R_i^c * W_{calc}^x * m_{Ti} = 3041,66 \text{ [daN*cm]}$$

$$M_r^y = R_i^c * W_{calc}^y * m_{Ti} = 3041,66 \text{ [daN*cm]}$$

$$\frac{+M_{ef}^x / M_r^x + -M_{ef}^y / M_r^y}{+M_{ef}^x / M_r^x + -M_{ef}^y / M_r^y} = 0,356 \leq 1$$

c) Verificarea de sargeata:

$$f_{max} \leq f_{adm} \quad f_{adm} = L/150 = dc/150 = 0,53 \text{ cm} \quad (f_{adm} - \text{tab.4.12, p.104})$$

$$f_{max} = \sqrt{f_{max,x}^2 + f_{max,y}^2}$$

$$f_{max,x} = f_p^x + f_z^x$$

$$f_{max,(x,y)} = f_{inst,(x,y)} (1 + k_{def})$$

$$f_{max,(x,y)} = f_{max,(x,y)}^p + f_{max,(x,y)}^z$$

K_{def} = - coef care tine seama de durata de actiune a incarcarii; (tab.4.13 p. 105)

$K_{def} = 0,50$ - incarcare permanenta;

$K_{def} = 0,25$ - incarcare din zapada;

$K_{def} = 0,00$ - incarcare de scurta durata;

$$f_{inst} = 5/384 * (q * l^4) / (E * I) \quad \text{- sargeata instantanee;}$$

$E = 113000$ [daN/cm²] - modulul de elasticitate paralel cu fibrele; (tab.4.6 p.)

$I_x = I_y = 52,08$ [cm⁶] - momentul de inertie al sipcii;

$q = \dots$ - incarcare normata;

$l = 80$ [cm] - deschiderea de calcul a sipcii; $l = l_c$;

$$f_{inst,x}^p = 0,001 \text{ [cm]}$$

$$f_{inst,y}^p = 0,004 \text{ [cm]}$$

$$f_{inst,x}^z = 0,012 \text{ [cm]}$$

$$f_{inst,y}^z = 0,043 \text{ [cm]}$$

$$f_{max,x}^p = 0,002 \text{ [cm]}$$

$$f_{max,y}^p = 0,006 \text{ [cm]}$$

$$f_{max,x}^z = 0,014 \text{ [cm]}$$

$$f_{max,y}^z = 0,054 \text{ [cm]}$$

$$f_{max,x} = 0,016 \text{ [cm]}$$

$$f_{max,y} = 0,060 \text{ [cm]}$$

$$f_{max} = 0,06 < f_{adm} = 0,53 \text{ [cm]}$$

2) Dimensionarea elementelor componente ale sarpantei

2.1) Dimensionarea capriilor:

- sectiune :	[cm]	b=	10	h=	15
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-distanța dintre caprii:	dc =	0,80	[m]
-deschiderea maximă pe direcția înclinată:lc=		2,75	[m]
-deschiderea maximă pe direcția orizontală:d=		2,65	[m]

a) Incarcari:

- incarcari de calcul:

♦ permanente:

$$g_p^c = g_p^c \cdot dc \cdot \cos \alpha = 26,60 \text{ [daN/m]}$$

♦ din zapada:

$$p_z^c = p_z^c \cdot dc \cdot \cos^2 \alpha = 236,82 \text{ [daN/m]}$$

♦ utila:

$$p_u^c = p_u^c \cdot \cos \alpha = 0,00 \text{ [daN/m]}$$

- incarcari normate:

♦ permanente:

$$g_p^n = g_p^n \cdot dc \cdot \cos \alpha = 19,71 \text{ [daN/m]}$$

♦ din zapada:

$$p_z^n = p_z^n \cdot dc \cdot \cos^2 \alpha = 111,97 \text{ [daN/m]}$$

♦ utila:

$$p_u^n = p_u^n \cdot \cos \alpha = 0,00 \text{ [daN/m]}$$

b) Verificarea de rezistenta:

$$M_{\max} \leq M_r$$

$$M_{\max} = \max(M_I, M_{II})$$

$$M_I = (g_p^c + p_z^c) \cdot l_c^2 / 8 = 249,01 \text{ -momentul din gruparea I: p+z}$$

$$M_{II} = (g_p^c + p_u^c) \cdot l_c^2 / 8 = 25,15 \text{ -momentul din gruparea II: p+u}$$

$$M_{\max} = 249,01 \text{ [daNm]}$$

$$M_r = R_i^c \cdot W_{\text{calc}} \cdot m_{Ti} = 54749,87 \text{ [daNcm]} = 547,50 \text{ [daNm]}$$

$$R_i^c = (m_{ui} \cdot m_{di} \cdot R_i) / \gamma = 146,00 \text{ [daN/cm}^2\text{]}$$

$$W_x = b \cdot h^2 / 6 = 375,00 \text{ [cm}^3\text{]}$$

$$M_{\max} < M_r$$

$$249,01$$

<

$$547,50$$

[daNm]

Dimensiunile alese sunt corecte

c) Verificarea de sageata:

$$f_{\max} \leq f_{\text{adm}}$$

$$f_{\text{adm}} = L/200 = l_c/200 = 1,38 \text{ cm}$$

$$f_{\max} = \max(f_I, f_{II});$$

(f_{adm} - tab.4.12, p.104)

$$f_I = f_{\max}^p + f_{\max}^z$$

- gruparea I: p+z;

$$f_{II} = f_{\max}^p + f_{\max}^u$$

- gruparea II: p+u;

$$f_{\max} = f_{\text{inst}(x,y)} (1 + k_{\text{def}})$$

$$f_{\text{inst}} = 5/384 \cdot (q \cdot l^4) / (E \cdot I)$$

- sageata instantanee;

$$E = 113000 \text{ [daN/cm}^2\text{]} \text{ - modulul de elasticitate paralel cu fibrele;}$$

(tab.4.6 p. 95)

$$I_x = 2812,50 \text{ [cm}^3\text{]} \text{ - momentul de inertie ;}$$

$$q = \dots \text{ - incarcare normata;}$$

$$l = 275 \text{ [cm]} \text{ - deschiderea de calcul ; } l = l_c ;$$

$$f_{inst}^p = 0,05 \text{ [cm]}$$

$$f_{inst}^z = 0,26 \text{ [cm]}$$

$$f_{inst}^u = 0,00 \text{ [cm]}$$

$$f_{max}^p = 0,1 \text{ [cm]}$$

$$f_{max}^z = 0,3 \text{ [cm]}$$

$$f_{max}^u = 0,0 \text{ [cm]}$$

$$f_i = 0,4 \text{ [cm]}$$

$$f_{II} = 0,1 \text{ [cm]}$$

$$f_{max} = 0,40 \text{ [cm]}$$

<

$$f_{adm} = 1,38 \text{ [cm]}$$

Dimensiunile alese sunt corecte

2.2) Dimensionarea panelor:

- sectiune :

$$b = 15$$

$$h = 15$$

[cm]

- deschiderea maxima pe directia orizontala:

$$T = 2,50 \text{ [m]}$$

-distanța echivalenta de pe care sunt preluate incarcările pe:

- inclinat

$$l = 2,70 \text{ [m]}$$

- orizontal

$$d_2 = 2,62 \text{ [m]}$$

- densitatea : $\rho = 600$ [daN/m]

- pana dreapta;

a) Incarcari:

- incarcari de calcul:

♦ proprie:

$$g_{pr,p}^c = 1.1 \cdot \rho \cdot b \cdot h = 14,85 \text{ [daN/m]}$$

♦ permanente:

$$g_{p,p}^c = g_p^c \cdot l + g_{pr,p}^c = 111,07 \text{ [daN/m]}$$

♦ din zapada:

$$p_{z,p}^c = p_z^c \cdot d_2 = 831,20 \text{ [daN/m]}$$

♦ utila:

$$p_{u,p}^c = p_u^c = 0 \text{ [daN/m]}$$

- incarcari normate:

♦ proprie:

$$g_{pr,p}^n = \rho \cdot b \cdot h = 13,5 \text{ [daN/m]}$$

♦ permanente:

$$g_{p,p}^n = g_p^n \cdot l + g_{pr,p}^n = 84,78 \text{ [daN/m]}$$

♦ din zapada:

$$p_{z,p}^n = p_z^n \cdot d_2 = 393,00 \text{ [daN/m]}$$

♦ utila:

$$p_{u,p}^n = p_u^c = 0 \text{ [daN/m]}$$

b) Verificarea de rezistenta:

$$M_{max} \leq M_r$$

$$M_{max} = \max(M_I, M_{II})$$

$$M_{g,p} = g_{p,p}^c * T^2 / 8 = 86,78 \text{ [daNm]} \quad \text{-momentul din incarcari permanente;}$$

$$M_{p,z} = p_{z,p}^c * T^2 / 8 = 649,37 \text{ [daNm]} \quad \text{-momentul din incarcarea cu zapada;}$$

$$M_{p,u} = p_{u,p}^c * T / 4 = 0,00 \text{ [daNm]} \quad \text{-momentul din incarcarea utila;}$$

M_I = - momentul maxim din gruparea p+z;

M_{II} = - momentul maxim din gruparea p+u;

$$M_{max} = 736,15 \text{ [daNm]}$$

$$M_r = R_i^c * W_{calc} * m_{Ti} = 821,25 \text{ [daNm]}$$

$$R_i^c = 146,00 \text{ [daN/cm}^2\text{]}$$

$$W_{calc} = 562,50 \text{ [cm}^3\text{]}$$

$$m_{Ti} = 1,0$$

M_{max}	$<$	M_r		
736,15	$<$	821,25	[daNm]	Dimensiunile alese sunt corecte

Verificarea de sargeata:

$$f_{adm} = L/200 = 1,25 \text{ [cm]}$$

$$f_{max} = f_I + f_{II}$$

f_I - - sargeata datorata incarcarii permanente;

f_{II} - - sargeata datorata incarcarii din zapada;

$$f_i = f_{i,inst(x,y)}(1+k_{def})$$

$$f_{i,inst} = 5/384 * (q * l^4) / (E * I)$$

$$I = 4218,75 \text{ [cm}^3\text{]}$$

$$f_{I,inst} = 0,09 \text{ [cm]} \quad f_I = 0,14 \text{ [cm]}$$

$$f_{II,inst} = 0,42 \text{ [cm]} \quad f_{II} = 0,52 \text{ [cm]}$$

f_{max}	0,66	$<$	f_{adm}	1,25	[cm]	Dimensiunile alese sunt corecte
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2.3) Dimensionarea popilor:

- sectiune:

b=	15	[cm]
h=	15	[cm]

$$- d_2 = 2,65 \text{ [m]}$$

$$- T = 2,50 \text{ [m]}$$

- aria de calcul:

$$A_c = 225 \text{ [cm}^2\text{]}$$

- inaltimea popului:

l=	240	[cm]
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- supraf pe orizontala i:

$$S_o = 8,30 \text{ [m}^2\text{]} \quad (=d_2 * T)$$

a) Incarcari:

- incarcari de calcul:

◆ greutate proprie;

$$g_{pr,pop}^c = 1.1 * p * b * h = 14,85 \text{ [daN/m]}$$

◆ incarcarea permanenta:

$$N_{p,pop}^c = g_p^c / \cos\alpha * S_o + g_{pr}^c * T + g_{pr}^c * l = 347,7714 \text{ [daN]}$$

◆ incarcarea zapada:

$$N_{z,pop}^c = p_z^c * S_o = 2633,18 \text{ [daN]}$$

$$N_{pop}^c = N_{p,pop}^c + N_{z,pop}^c = 2980,95 \text{ [daN]} \quad \text{- incarcarea aferenta popului;}$$

C_r - capacitatea portanta a popului la compresiune paralela cu fibrele;

$$C_r = R_{c,II}^c * A_c * \rho_c * m_{Tc}$$

$$m_{Tc} = 1,0 \quad \text{- coeficient de tratare - lemn tratat pe suprafata;}$$

ρ_c - - coeficient de flambaj; (limitat de tab. 4.15, p108);
 $A_c = 225$ [cm²] - aria sectiunii de calcul;
 $R_{c,II}^c$ = - rezistenta de calcul la compresiune II cu fibrele;

$$R_{c,II}^c = (m_{uc} * m_{dc} * R_{c,II}) / \gamma_c = 93,76 \text{ [daN/cm}^2\text{]}$$

$$m_{uc} = 1$$

$$m_{dc,i} = (m_{d1} * g_p + m_{d2} * g_z) / (g_p + g_z)$$

$$m_{dc,1} = 0,80 \text{ - pt incarcari permanente; (tab. 4.8, p96)}$$

$$m_{dc,2} = 1,00 \text{ - pt incarcari din zapada;}$$

$$m_{dc} = 0,977$$

$$R_{c,II} = 120 \text{ [daN/cm}^2\text{]} \text{ - rezistenta caracteristica la compresiune;}$$

- rasinoase cl II de calitate; (tab. 4.5, p94)

$$(\gamma_c) = 1,25 \text{ - coef partial de siguranta, fct de tipul solicitarii; (tab. 4.9, p97)}$$

ρ_c - coeficient de flambaj functie de zveltete λ ;

$$\lambda = l_f / i = 55,43 < 75 \text{ (tab. 4.15, p108);}$$

$$l_f = 2,40 \text{ [m]} \text{ - lungimea de flambaj } l_f = l;$$

$$i = 4,33 = \sqrt{I/A} \text{ - raza de giratie;}$$

$$I = 4218,75 \text{ [cm}^3\text{]} \text{ - mom de inertie}$$

$$\rho_c = 0,754$$

$$C_r = 15911,45 \text{ [daN]}$$

$$N_{pop}^{calc} = 2980,95 \text{ [daN]}$$

intocmit: ing. Marin Teau

