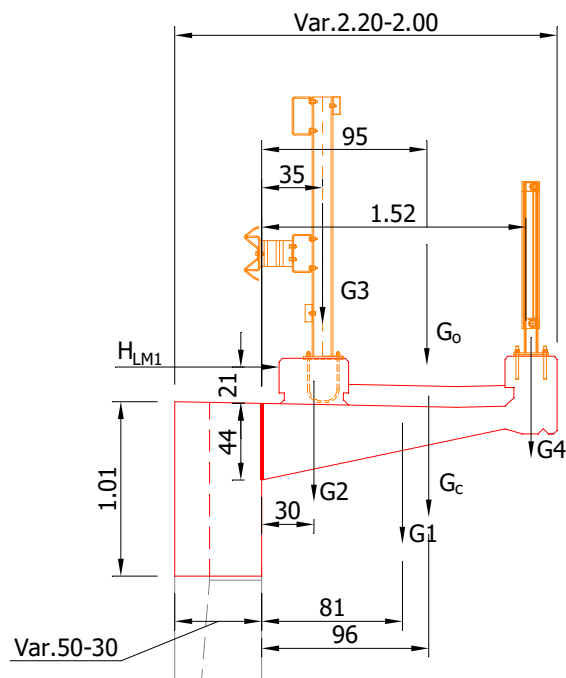


**Anexa A - Pod DN7 km 377+212****Calcul consola culee**

$$\gamma_{\text{beton}} := 25 \frac{\text{kN}}{\text{m}^3} \quad \gamma_{\text{cale}} := 22 \frac{\text{kN}}{\text{m}^3} \quad t_f := 10 \text{ kN} \quad g_{\text{om}} := 5 \frac{\text{kN}}{\text{m}^2}$$

**1. Gruparea fundamentala****Actiuni din greutati permanente**

$$G_1 := 0.5245 \text{ m}^2 \cdot \gamma_{\text{beton}} \cdot 1 \text{ m} = 13.11 \cdot \text{kN} \quad b_1 := 0.81 \text{ m} \quad \gamma_1 := 1.35$$

$$G_2 := 0.1029 \text{ m}^2 \cdot 0.40 \text{ m} \cdot \gamma_{\text{beton}} = 1.029 \cdot \text{kN} \quad b_2 := 0.97 \text{ m} \quad \gamma_2 := 1.35$$

$$G_3 := 2 \frac{\text{kN}}{\text{m}} \cdot 1 \text{ m} = 2 \cdot \text{kN} \quad b_3 := 0.35 \text{ m} \quad \gamma_3 := 1.35$$

$$G_4 := 1 \frac{\text{kN}}{\text{m}} \cdot 1 \text{ m} = 1 \cdot \text{kN} \quad b_4 := 1.52 \text{ m} \quad \gamma_4 := 1.35$$

$$G_o := g_{\text{om}} \cdot 1 \text{ m} \cdot 1 \text{ m} = 5 \cdot \text{kN} \quad b_o := 0.95 \text{ m} \quad \gamma_o := 1.35$$

$$M_c := G_1 \cdot b_1 \cdot \gamma_1 + G_2 \cdot b_2 \cdot \gamma_2 + G_3 \cdot b_3 \cdot \gamma_3 + G_4 \cdot b_4 \cdot \gamma_4 + G_o \cdot b_o \cdot \gamma_o = 26.553 \cdot \text{kN} \cdot \text{m}$$

**Caracteristici materiale**

$$f_{ck} := 35 \frac{\text{N}}{\text{mm}^2}$$

$$f_{yk} := 500 \cdot \frac{\text{N}}{\text{mm}^2}$$

$$f_{ctm} := 3.2 \frac{\text{N}}{\text{mm}^2}$$

$$f_{cd} := \frac{f_{ck} \cdot 0.85}{1.5} = 19.833 \cdot \frac{\text{N}}{\text{mm}^2} \quad f_{yd} := \frac{f_{yk} \cdot 1}{1.15} = 434.783 \cdot \frac{\text{N}}{\text{mm}^2}$$

$$\lambda := \begin{cases} 0.8 & \text{if } f_{ck} \leq 50 \frac{\text{N}}{\text{mm}^2} \\ \left[ 0.8 - \frac{\left( \frac{f_{ck}}{\frac{\text{N}}{\text{mm}^2}} - 50 \right)}{400} \right] & \text{if } 50 \frac{\text{N}}{\text{mm}^2} \leq f_{ck} \leq 90 \frac{\text{N}}{\text{mm}^2} \end{cases} \quad \lambda = 0.8$$

$$\eta := \begin{cases} 1 & \text{if } f_{ck} \leq 50 \frac{\text{N}}{\text{mm}^2} \\ \left[ 1 - \frac{\left( \frac{f_{ck}}{\frac{\text{N}}{\text{mm}^2}} - 50 \right)}{200} \right] & \text{if } 50 \frac{\text{N}}{\text{mm}^2} \leq f_{ck} \leq 90 \frac{\text{N}}{\text{mm}^2} \end{cases} \quad \eta = 1$$

**Caracteristici sectiune**

$$M_c = 26.553 \cdot \text{kN} \cdot \text{m}$$

$$h := 440 \text{mm} \quad b := 1000 \text{mm}$$

$$\phi := 16 \text{mm} \quad \phi_{et} := 0 \text{mm}$$

$$ac := 50 \text{mm}$$

$$a_s := \frac{\phi}{2} + \phi_{et} + ac = 58 \cdot \text{mm}$$

$$d := h - a_s = 382 \cdot \text{mm}$$

$$x_{lim} := \begin{cases} 0.55 \cdot d & \text{if } f_{ck} \leq 25 \cdot \frac{\text{N}}{\text{mm}^2} \\ 0.5 \cdot d & \text{if } f_{ck} > 25 \cdot \frac{\text{N}}{\text{mm}^2} \end{cases} \quad x_{lim} = 191 \cdot \text{mm}$$

$$A_{s,min} := \min \left( 0.26 \cdot \frac{f_{ctm}}{f_{yk}} \cdot b \cdot d, 0.0013 \cdot b \cdot d \right)$$

$$A_{s,min} = 496.6 \cdot \text{mm}^2$$

$$x := \frac{d - \sqrt{d^2 - \frac{2 \cdot M_c}{b \cdot \eta \cdot f_{cd}}}}{\lambda} = 4.401 \cdot \text{mm}$$

$$A_{s'} := \begin{cases} 0 & \text{if } x \leq x_{lim} \\ \text{"NECESAR"} & \text{if } x > x_{lim} \end{cases} \quad A_{s'} = 0$$

$$A_{s,neces} := \max \left( \frac{b \cdot \lambda \cdot x \cdot \eta \cdot f_{cd}}{f_{yd}}, A_{s,min} \right) = 4.966 \cdot \text{cm}^2$$

$$A_{l\phi} := \frac{\pi \phi^2}{4} = 2.011 \cdot \text{cm}^2$$

$$nr_{bare} := \text{ceil} \left( \frac{A_{s,neces}}{A_{l\phi}} \right) = 3 \quad \phi 16 \text{ la } 33\text{cm}$$

$$A_s := nr_{bare} \cdot A_{l\phi} = 603.19 \cdot \text{mm}^2$$

$$x_T := \frac{A_s \cdot f_{yd}}{\lambda \cdot b \cdot \eta \cdot f_{cd}} = 16.529 \cdot \text{mm}$$

$$M_{Rd} := b \cdot \lambda \cdot x_T \cdot \eta \cdot f_{cd} \cdot \left( d - \frac{\lambda \cdot x_T}{2} \right) = 98.447 \cdot \text{kN} \cdot \text{m}$$

$$M_{Rd'} := A_s \cdot f_{yd} \cdot \left( d - \frac{\lambda \cdot x_T}{2} \right) = 98.447 \cdot \text{kN} \cdot \text{m}$$

## 2. Gruparea accidentală

### Actiuni din greutate permanente

$$G_1 := 0.5245 \text{m}^2 \cdot \gamma_{\text{beton}} \cdot 1 \text{m} = 13.11 \cdot \text{kN}$$

$$b_1 := 0.81 \text{m}$$

$$\gamma_{1a} := 1$$

$$G_2 := 0.1029 \text{m}^2 \cdot 0.40 \text{m} \cdot \gamma_{\text{beton}} = 1.029 \cdot \text{kN}$$

$$b_2 := 0.97 \text{m}$$

$$\gamma_{2a} := 1$$

$$G_3 := 2 \frac{\text{kN}}{\text{m}} \cdot 1 \text{m} = 2 \cdot \text{kN}$$

$$b_3 := 0.35 \text{m}$$

$$\gamma_{3a} := 1$$

$$G_4 := 1 \frac{\text{kN}}{\text{m}} \cdot 1 \text{m} = 1 \cdot \text{kN}$$

$$b_4 := 1.52 \text{m}$$

$$\gamma_{4a} := 1$$

$$G_{om} := g_{om} \cdot 1 \text{m} \cdot 1 \text{m} = 5 \cdot \text{kN}$$

$$b_{om} := 0.95 \text{m}$$

$$\gamma_{om} := 1$$

$$M_a := G_1 \cdot b_1 \cdot \gamma_1 + G_2 \cdot b_2 \cdot \gamma_2 + G_3 \cdot b_3 \cdot \gamma_3 + G_4 \cdot b_4 \cdot \gamma_4 + G_o \cdot b_o \cdot \gamma_o = 20.579 \cdot \text{kN} \cdot \text{m}$$

### Actiuni din izbirea vehiculelor in bordura

$$H_{LM1} := 100 \text{ kN}$$

$$b_{LM1} := 0.21 \cdot \text{m}$$

$$\gamma_{LM1} := 1$$

$$M_{cLM1} := H_{LM1} \cdot b_{LM1} \cdot \gamma_{LM1} = 21 \cdot \text{kN} \cdot \text{m}$$

$$M_{ca} := M_c + M_{cLM1} = 41.579 \cdot \text{kN} \cdot \text{m}$$

### Caracteristici materiale

$$f_{ck} := 35 \frac{\text{N}}{\text{mm}^2}$$

$$f_{yk} := 500 \cdot \frac{\text{N}}{\text{mm}^2}$$

$$f_{ctm} := 3.2 \frac{\text{N}}{\text{mm}^2}$$

$$f_{cd} := \frac{f_{ck} \cdot 0.85}{1.5} = 19.833 \cdot \frac{\text{N}}{\text{mm}^2} \quad f_{yld} := \frac{f_{yk} \cdot 1}{1.15} = 434.783 \cdot \frac{\text{N}}{\text{mm}^2}$$

$$\lambda := \begin{cases} 0.8 & \text{if } f_{ck} \leq 50 \frac{\text{N}}{\text{mm}^2} \\ \left[ 0.8 - \frac{\left( \frac{f_{ck}}{\frac{\text{N}}{\text{mm}^2}} - 50 \right)}{400} \right] & \text{if } 50 \frac{\text{N}}{\text{mm}^2} \leq f_{ck} \leq 90 \cdot \frac{\text{N}}{\text{mm}^2} \end{cases} \quad \lambda = 0.8$$

$$\eta := \begin{cases} 1 & \text{if } f_{ck} \leq 50 \frac{\text{N}}{\text{mm}^2} \\ \left[ 1 - \frac{\left( \frac{f_{ck}}{\frac{\text{N}}{\text{mm}^2}} - 50 \right)}{200} \right] & \text{if } 50 \frac{\text{N}}{\text{mm}^2} \leq f_{ck} \leq 90 \cdot \frac{\text{N}}{\text{mm}^2} \end{cases} \quad \eta = 1$$

### Caracteristici sectiune

$$M_{ca} = 41.579 \cdot \text{kN} \cdot \text{m}$$

$$h := 440 \text{ mm} \quad b := 1000 \text{ mm}$$

$$\phi := 14 \text{ mm} \quad \phi_{et} := 0 \text{ mm}$$

$$ac := 50 \text{ mm}$$

$$a_s := \frac{\phi}{2} + \phi_{et} + ac = 57 \cdot \text{mm}$$

$$d := h - a_s = 383 \cdot \text{mm}$$

$$x_{lim} := \begin{cases} 0.55 \cdot d & \text{if } f_{ck} \leq 25 \cdot \frac{N}{\text{mm}^2} \\ 0.5 \cdot d & \text{if } f_{ck} > 25 \cdot \frac{N}{\text{mm}^2} \end{cases} \quad x_{lim} = 191.5 \cdot \text{mm}$$

$$A_{s,min} := \min \left( 0.26 \cdot \frac{f_{ctm}}{f_{yk}} \cdot b \cdot d, 0.0013 \cdot b \cdot d \right)$$

$$A_{s,min} = 497.9 \cdot \text{mm}^2$$

$$x := \frac{d - \sqrt{d^2 - \frac{2 \cdot M_{ca}}{b \cdot \eta \cdot f_{cd}}}}{\lambda} = 6.892 \cdot \text{mm}$$

$$A_s := \begin{cases} 0 & \text{if } x \leq x_{lim} \\ \text{"NECESAR"} & \text{if } x > x_{lim} \end{cases} \quad A_{s'} = 0$$

$$A_{s,neces} := \max \left( \frac{b \cdot \lambda \cdot x \cdot \eta \cdot f_{cd}}{f_{yd}}, A_{s,min} \right) = 4.979 \cdot \text{cm}^2$$

$$A_{1\phi} := \frac{\pi \phi^2}{4} = 1.539 \cdot \text{cm}^2$$

$$nr_{bare} := \text{ceil} \left( \frac{A_{s,neces}}{A_{1\phi}} \right) = 4 \quad \phi 14 \text{ la } 25 \text{cm}$$

$$A_s := nr_{bare} \cdot A_{1\phi} = 6.16 \cdot \text{cm}^2$$

$$x_s := \frac{A_s \cdot f_{yd}}{\lambda \cdot b \cdot \eta \cdot f_{cd}} = 16.873 \cdot \text{mm}$$

$$M_{Rd} := b \cdot \lambda \cdot x_r \cdot \eta \cdot f_{cd} \cdot \left( d - \frac{\lambda \cdot x_r}{2} \right) = 100.729 \cdot \text{kN} \cdot \text{m}$$

$$M_{Rd} := A_s \cdot f_{yd} \cdot \left( d - \frac{\lambda \cdot x_r}{2} \right) = 100.729 \cdot \text{kN} \cdot \text{m}$$