

ВХОДНИ ДАННИ / ADDITIONAL INFORMATION**Нормативни натоварвания от вятър//Wind load**

Съгласно наредба №3 за основни положения за проектиране на конструкциите на строежите и за въздействията върху тях от 2004г, раздел VI, чл. 94

Acc. to Regulation No3 for Basic conditions for building constructions design and interferences, published 2004, section VI, article. 94

Нормативното натоварване от вятър при скорост на вятъра:

Wind load corresponding to wind velocity:

$$v := 35 \cdot \frac{\text{m}}{\text{s}}$$

$$W_m := \frac{v^2}{1600} \cdot \frac{1000 \cdot \text{kg}}{\text{m}^3}$$

$$W_m = 0.77 \frac{\text{kN}}{\text{m}^2}$$

Определяне на сеизмичната сила / Earthquake load

Съгласно "Наредба №РД-02-20-2 за проектиране на сгради и съоръжения в земетръсни райони" от 2012

Acc. to " Regulation №РД-02-20-2 for building design in seismic areas", published 2007

изчислителната сеизмична сила е/ the calculated earthquake load is: $E_{ik} = E_{ik} = C \cdot R \cdot K_C \cdot \beta_i \cdot \eta_{ik} \cdot Q_k = a_h \cdot Q_k = a_v \cdot Q_k$,
където/ where:

$C_s := 1.5$ коефициент на значимост на сградите и съоръженията за електро и термични централи от общонационално значение с мощност над 100MW;
coefficient for building and equipment priority of electrical and thermal power plants, rated over 100MW

$R_s := 0.33$ коефициент на реагиране на конструкцията;

$K_C := 0.27$ сеизмичен коефициент/ seismic coefficient

$\beta_i := 2.5$ динамичен коефициент за трета група почви;

$\eta_{ik} := 1$ коефициент за разпределение на изчислителното сеизмично натоварване;

$$a_h := C \cdot R \cdot K_C \cdot \beta_i \cdot \eta_{ik}$$

$$a_v := a_h$$

$$a_h = 0.33$$

$$a_v = 0.33$$

Модул на еластичност на профилна стомана ВСт3/ / Elastic modulus steel ВСт3

$$E_{St3} := 210000 \cdot \text{MPa}$$

Модул на еластичност на бетон клас В20/ Elastic modulus concrete class В20

$$E_b := 27500 \cdot \text{MPa}$$

Модул на еластичност на стомана А III/ Elastic modulus steel AIII

$$E_s := 200000 \cdot \text{MPa}$$

КОЕФИЦИЕНТИ ЗА НАТОВАРВАНЕ/ PARTIAL SAFETY FACTORS

$\gamma_M := 1.10$ коефициент за натоварване за стомана/
partial safety factor for steel

$\gamma_C := 1.20$ коефициент за натоварване за бетон/
partial safety factor for concrete

Максимални напрежения/ Maximum stresses:

S235 JRG2 (DIN 18800):

C380/230 (ВСт3сп5) (БДС2592-71)

$$f_{Y24} := 240 \cdot \frac{\text{N}}{\text{mm}^2}$$

$$f_{Sta24} := \frac{f_{Y24}}{\gamma_M}$$

$$f_{Sta24} = 218.18 \frac{\text{N}}{\text{mm}^{2.00}}$$

S355 JRG3 (DIN 18800):

C500/360 (10Г2СФ) (БДС4880-74)

$$f_{Y36} := 360 \cdot \frac{\text{N}}{\text{mm}^2}$$

$$f_{Sta36} := \frac{f_{Y36}}{\gamma_M}$$

$$f_{Sta36} = 327.27 \frac{\text{N}}{\text{mm}^{2.00}}$$

Максимални напрежения на смачкване/ Maximum stresses:

S235JRG2:
(DIN 18800):

C380/230

(ВСт3сп5)

(БДС2592-71)

M12

$e_{12} := 25\text{mm}$

$d_{12} := 14\text{mm}$

$$f_{ba2412} := \frac{f_{Y24}}{\gamma_M} \left(1.1 \frac{e_{12}}{d_{12}} - 0.3 \right)$$

$$f_{ba2412} = 363.12 \frac{\text{N}}{\text{mm}^2}$$

M16

$e_{16} := 35\text{mm}$

$d_{16} := 18\text{mm}$

$$f_{ba2416} := \frac{f_{Y24}}{\gamma_M} \left(1.1 \frac{e_{16}}{d_{16}} - 0.3 \right)$$

$$f_{ba2416} = 401.21 \frac{\text{N}}{\text{mm}^{2.00}}$$

M20	$e_{20} := 40\text{mm}$	$d_{20} := 22\text{mm}$	$f_{ba2420} := \frac{f_{Y24}}{\gamma M} \left(1.1 \frac{e_{20}}{d_{20}} - 0.3 \right)$	$f_{ba2420} = 370.91 \frac{\text{N}}{\text{mm}^{2.00}}$
M24	$e_{24} := 50\text{mm}$	$d_{24} := 27\text{mm}$	$f_{ba2424} := \frac{f_{Y24}}{\gamma M} \left(1.1 \frac{e_{24}}{d_{24}} - 0.3 \right)$	$f_{ba2424} = 378.99 \frac{\text{N}}{\text{mm}^{2.00}}$
S355 JRG3 (DIN 18800): C500/360 (10Г2СФ) (БДС4880-74)	M12		$f_{ba3612} := \frac{f_{Y36}}{\gamma M} \left(1.1 \frac{e_{12}}{d_{12}} - 0.3 \right)$	$f_{ba3612} = 544.68 \frac{\text{N}}{\text{mm}^{2.00}}$
	M16		$f_{ba3616} := \frac{f_{Y36}}{\gamma M} \left(1.1 \frac{e_{16}}{d_{16}} - 0.3 \right)$	$f_{ba3616} = 601.82 \frac{\text{N}}{\text{mm}^{2.00}}$
	M20		$f_{ba3620} := \frac{f_{Y36}}{\gamma M} \left(1.1 \frac{e_{20}}{d_{20}} - 0.3 \right)$	$f_{ba3620} = 556.36 \frac{\text{N}}{\text{mm}^{2.00}}$
	M24		$f_{ba3624} := \frac{f_{Y36}}{\gamma M} \left(1.1 \frac{e_{24}}{d_{24}} - 0.3 \right)$	$f_{ba3624} = 568.48 \frac{\text{N}}{\text{mm}^{2.00}}$

За HV гайки 10.9 с 0.5 Fv начално усилие/ For HV-screws 10.9 with 0,5 Fv initial stressing:

S235JRG2:(DIN 18800): C380/230 (BCт3сп5) (БДС2592-71)	M12	$f_{ba24Fv} := 1.35 \frac{f_{Y24}}{\gamma M} \left(1.1 \frac{e_{12}}{d_{12}} - 0.3 \right)$	$f_{ba24Fv} = 490.21 \frac{\text{N}}{\text{mm}^{2.00}}$
S355 JRG3 (DIN 18800): C500/360 (10Г2СФ) (БДС4880-74)	M12	$f_{ba36Fv} := 1.35 \frac{f_{Y36}}{\gamma M} \left(1.1 \frac{e_{12}}{d_{12}} - 0.3 \right)$	$f_{ba36Fv} = 735.31 \frac{\text{N}}{\text{mm}^{2.00}}$

Максимално усилие на срязване/ Maximum shearing stress:

максимална якост на скъсване/
tensile breaking stress:

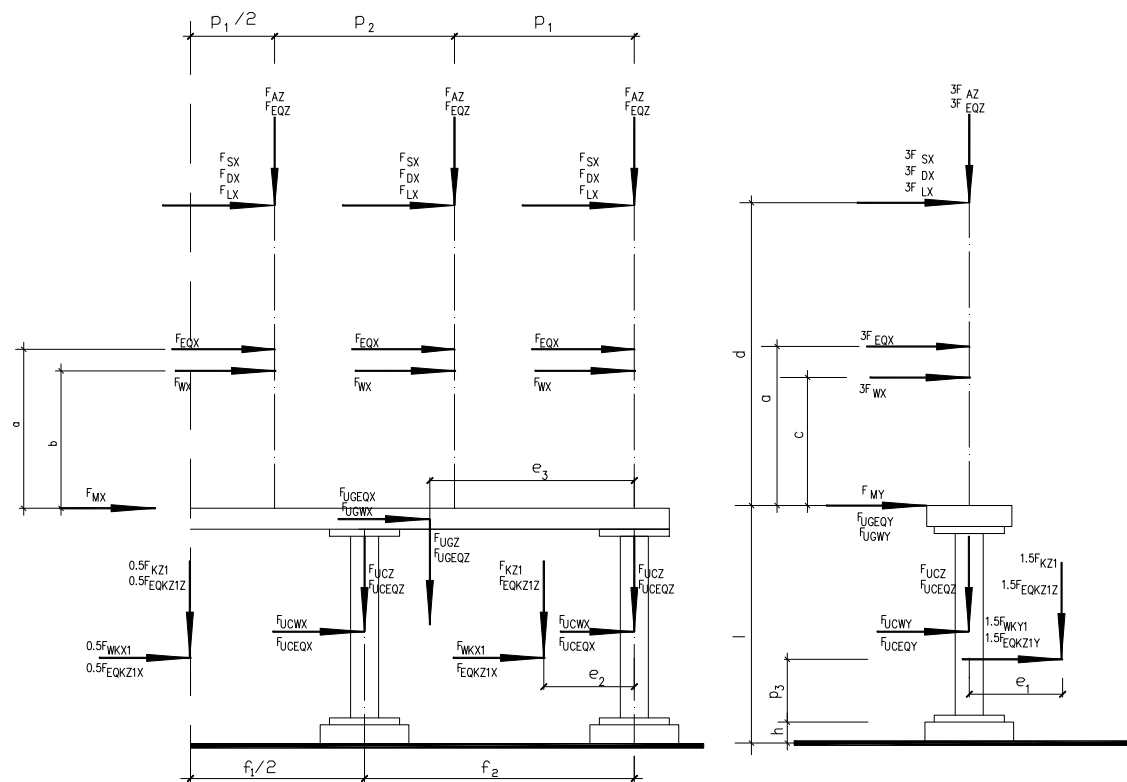
f_K

$\alpha_{a4.6} := 0.60$	$f_{K4.6} := 400 \frac{\text{N}}{\text{mm}^2}$	$f_{a4.6} := \frac{f_{K4.6} \cdot \alpha_{a4.6}}{\gamma M}$	$f_{a4.6} = 218.18 \frac{\text{N}}{\text{mm}^{2.00}}$
$\alpha_{a5.6} := 0.60$	$f_{K5.6} := 500 \frac{\text{N}}{\text{mm}^2}$	$f_{a5.6} := \frac{f_{K5.6} \cdot \alpha_{a5.6}}{\gamma M}$	$f_{a5.6} = 272.73 \frac{\text{N}}{\text{mm}^{2.00}}$
$\alpha_{a8.8} := 0.60$	$f_{K8.8} := 800 \frac{\text{N}}{\text{mm}^2}$	$f_{a8.8} := \frac{f_{K8.8} \cdot \alpha_{a8.8}}{\gamma M}$	$f_{a8.8} = 436.36 \frac{\text{N}}{\text{mm}^{2.00}}$
$\alpha_{a10.9} := 0.55$	$f_{K10.9} := 1000 \frac{\text{N}}{\text{mm}^2}$	$f_{a10.9} := \frac{f_{K10.9} \cdot \alpha_{a10.9}}{\gamma M}$	$f_{a10.9} = 500.00 \frac{\text{N}}{\text{mm}^{2.00}}$

Максимални усилия на опън/ Maximum tensile stress:

$f_{Y4.6} := 240 \frac{\text{N}}{\text{mm}^2}$	$f_{ta4.6} := 0.9 \frac{f_{Y4.6}}{\gamma M}$	$f_{ta4.6} = 196.36 \frac{\text{N}}{\text{mm}^{2.00}}$
$f_{Y5.6} := 300 \frac{\text{N}}{\text{mm}^2}$	$f_{ta5.6} := 0.9 \frac{f_{Y5.6}}{\gamma M}$	$f_{ta5.6} = 245.45 \frac{\text{N}}{\text{mm}^{2.00}}$
$f_{Y8.8} := 640 \frac{\text{N}}{\text{mm}^2}$	$f_{ta8.8} := 0.9 \frac{f_{Y8.8}}{\gamma M}$	$f_{ta8.8} = 523.64 \frac{\text{N}}{\text{mm}^{2.00}}$
$f_{Y10.9} := 900 \frac{\text{N}}{\text{mm}^2}$	$f_{ta10.9} := 0.9 \frac{f_{Y10.9}}{\gamma M}$	$f_{ta10.9} = 736.36 \frac{\text{N}}{\text{mm}^{2.00}}$

ОПРЕДЕЛЯНЕ НА УСИЛИЯТА НА ГОРЕН РЪБ ФУНДАМЕНТ
СХЕМА НА НАТОВАРВАНИЯТА
CACULATION OF UPPER EDGE FOUNDATION STRESS
LOAD DIAGRAM



Дименсии / Dimensions:

$l := 2500\text{mm}$ $h := 150\text{mm}$ $a := 825\text{mm}$ $b := 825\text{mm}$ $c := 825\text{mm}$ $d := 1650\text{mm}$ $p_1 := 1400\text{mm}$ $p_2 := 1300\text{mm}$ $p_3 := 1050\text{mm}$
 $n := l - h$ $n = 2350.00\text{mm}$ $e_1 := 350\text{mm}$ $e_2 := 700\text{mm}$ $e_3 := 1700\text{mm}$ $f_1 := 2300\text{mm}$ $f_2 := 2250\text{mm}$ $d_k := 240\text{mm}$

диаметър на съоръжението/ equipment diameter:

Товари от съоръжението/ Equipment loads:

ОСНОВНИ/ NORMAL:

Собствено тегло на съоръжението/
Dead load of equipment:

$$F_{AZn} := 1.90\text{kN} \quad F_{AZc} := 1.2 \cdot F_{AZn} \quad F_{AZc} = 2.28\text{kN}$$

$$F_{KZn} := 0.65\text{kN} \quad F_{KZc} := 1.2 \cdot F_{KZn} \quad F_{KZc} = 0.78\text{kN}$$

Вятър върху съоръжение/ Windload on equipment:

k_z - коефициент за отчитане на вятъра по височина/
windload height coefficient

по табл.9 на Наредба 3/
acc.to Regulation No3,tab.9 $k_z := 0.75$ $\gamma_{fw} := 1.4$

по схема 12а табл.8.2 на Наредба 3
acc.to diagram 12a,tab.8.2 of
Regulation No3

$$R_e := 0.88 \cdot d_k \cdot \sqrt{W_m \cdot k_z \cdot \gamma_{fw}} \cdot 10^5 \quad R_e = 5.99 \times 10^5 \frac{\text{m}^{0.5} \cdot \text{kg}^{0.5}}{\text{s}}$$

по схема 13 (т 1) табл.8.2 на Наредба 3 за/
acc.to Regulation No3,tab.8.2

$$\lambda_e := \frac{d}{d_k} \quad \lambda_e = 6.88$$

$$k := 0.617$$

$$\Delta := 0.001$$

- за стоманени конструкции/
for steel constructions:

$$\frac{\Delta}{d_k} = 4.17 \times 10^{-3} \frac{1}{\text{m}}$$

c_w - аеродинамичен коефициент/
streamline coefficient

$c_{\chi_{00}} := 0.52$ по схема 14 табл.8.2 на Наредба 3/
acc.to Regulation
No3,diagram14,tab.8.2

$c_w := k \cdot c_{\chi_{00}}$ $c_w = 0.32$

нормативна стойност на статичната компонента на натоварване от вятър/
static winload:

$$W_n := W_m \cdot k_z \cdot c_w \quad W_n = 0.18 \frac{\text{kN}}{\text{m}^2}$$

$$F_{WXn} := d_k \cdot W_n \cdot d \quad F_{WXn} = 0.07 \text{ kN} \quad F_{WXc} := F_{WXn} \cdot \gamma_{fw} \quad F_{WXc} = 0.10 \text{ kN}$$

$$F_{WYn} := d_k \cdot W_n \cdot d \quad F_{WYn} = 0.07 \text{ kN} \quad F_{WYc} := F_{WYn} \cdot \gamma_{fw} \quad F_{WYc} = 0.10 \text{ kN}$$

$$h_k := 0.6 \cdot n \quad b_k := 0.4 \cdot m \quad F_{WKXn} := (0.8 + 0.6) \cdot h_k \cdot b_k \cdot W_m \quad F_{WKXn} = 0.26 \text{ kN} \quad F_{WKXc} := F_{WKXn} \cdot \gamma_{fw} \quad F_{WKXc} = 0.36 \text{ kN}$$

$$F_{WKYn} := (0.8 + 0.6) \cdot h_k \cdot b_k \cdot W_m \quad F_{WKYn} = 0.26 \text{ kN} \quad F_{WKYc} := F_{WKYn} \cdot \gamma_{fw} \quad F_{WKYc} = 0.36 \text{ kN}$$

Опъвателна сила на проводник:
Static conductor tension

$$F_{SXn} := 0.00 \cdot \text{kN} \quad F_{SXc} := 1.3 F_{SXn} \quad F_{SXc} = 0.00 \text{ kN}$$

$$F_{SYn} := 0.50 \cdot \text{kN} \quad F_{SYc} := 1.3 F_{SYn} \quad F_{SYc} = 0.65 \text{ kN}$$

Вятър върху проводник/
Windload on conductor:

$$F_{LXn} := 0.10 \cdot \text{kN} \quad F_{LXc} := \gamma_{fw} F_{LXn} \quad F_{LXc} = 0.14 \text{ kN}$$

$$F_{LYn} := 0.00 \cdot \text{kN} \quad F_{LYc} := \gamma_{fw} F_{LYn} \quad F_{LYc} = 0.00 \text{ kN}$$

Монтажен товар/ Errection load:

$$F_{MXn} := 1.00 \cdot \text{kN} \quad F_{MXc} := 1.3 F_{MXn} \quad F_{MXc} = 1.30 \text{ kN}$$

$$F_{MYn} := 1.00 \cdot \text{kN} \quad F_{MYc} := 1.3 F_{MYn} \quad F_{MYc} = 1.30 \text{ kN}$$

$$F_{MZn} := 1.00 \cdot \text{kN} \quad F_{MZc} := 1.3 F_{MZn} \quad F_{MZc} = 1.30 \text{ kN}$$

ОСОБЕНИ/EXCEPTIONAL

Късо съединение/ Short-circuit forces: $F_{DXn} := 2.00 \cdot \text{kN} \quad F_{DYn} := 0 \cdot \text{kN}$

Сили от превключване/
Switching forces:

$$F_{CXn} := 0.00 \cdot \text{kN} \quad F_{CYn} := 0.00 \cdot \text{kN} \quad F_{CZmaxn} := 0.00 \cdot \text{kN} \quad F_{CZminn} := 0.00 \cdot \text{kN}$$

Сеизмични сили/
Earthquake load:

$$F_{EQXn} := a_h \cdot F_{AZn} \quad F_{EQXn} = 0.63 \text{ kN}$$

$$F_{EQYn} := a_h \cdot F_{AZn} \quad F_{EQYn} = 0.63 \text{ kN}$$

$$F_{EQZn} := a_v \cdot F_{AZn} \quad F_{EQZn} = 0.63 \text{ kN}$$

$$F_{EQKXn} := F_{KZn} \cdot a_h \quad F_{EQKXn} = 0.22 \text{ kN}$$

$$F_{EQKYn} := F_{KZn} \cdot a_h \quad F_{EQKYn} = 0.22 \text{ kN}$$

$$F_{EQKZn} := F_{KZn} \cdot a_v \quad F_{EQKZn} = 0.22 \text{ kN}$$

Опорна конструкция/ Supporting structures Колона/ Column

Собствено тегло / Dead load: $q_{uczn} := 0.25 \cdot \frac{\text{kN}}{\text{m}} \quad F_{UCZn} := q_{uczn} \cdot n \quad F_{UCZn} = 0.59 \text{ kN}$

$$F_{UCZc} := 1.2 \cdot F_{UCZn} \quad F_{UCZc} = 0.71 \text{ kN}$$

Вятър върху опорна конструкция/Windload:

$$b_{cx} := 80 \cdot \text{mm} \quad b_{cy} := 140 \cdot \text{mm}$$

$$q_{cwxn} := b_{cx} \cdot (0.6 + 0.8) \cdot W_m \quad q_{cwxn} = 0.09 \frac{\text{kN}}{\text{m}} \quad q_{cwyn} := b_{cy} \cdot (0.6 + 0.8) \cdot W_m \quad q_{cwyn} = 0.15 \frac{\text{kN}}{\text{m}}$$

$$F_{UCWXn} := q_{cwxn} \cdot n \quad F_{UCWXn} = 0.20 \text{ kN} \quad F_{UCWYn} := q_{cwyn} \cdot n \quad F_{UCWYn} = 0.35 \text{ kN}$$

$$F_{UCWXc} := \gamma_{fw} \cdot F_{UCWXn} \quad F_{UCWXc} = 0.28 \text{ kN} \quad F_{UCWYc} := \gamma_{fw} \cdot F_{UCWYn} \quad F_{UCWYc} = 0.49 \text{ kN}$$

Сеизмични сили/
Earthquake load:

$$F_{UCEQXn} := a_h \cdot F_{UCZn} \quad F_{UCEQXn} = 0.20 \text{ kN}$$

$$F_{UCEQYn} := a_h \cdot F_{UCZn} \quad F_{UCEQYn} = 0.20 \text{ kN}$$

$$F_{UCEQZn} := a_v \cdot F_{UCZn} \quad F_{UCEQZn} = 0.20 \text{ kN}$$

Греда/ Вeam

Собствено тегло/Dead load: $q_{ugzn} := 0.4 \cdot \frac{kN}{m}$ $F_{UGZn} := q_{ugzn} \cdot 2 \cdot e_3$ $F_{UGZc} := 1.1 \cdot F_{UGZn}$ $F_{UGZc} = 2.99 kN$

Вятър върху опорна конструкция / Windload:

$b_g := 180 \cdot mm$ $q_{gwxn} := b_g \cdot (0.6 + 0.8) \cdot W_m$ $q_{gwxn} = 0.19 \frac{kN}{m}$ $q_{gwyn} := b_g \cdot (0.6 + 0.8) \cdot W_m$ $q_{gwyn} = 0.19 \frac{kN}{m}$

$F_{UGWXn} := 0$ $F_{UGWXn} = 0.00 kN$ $F_{UGWYn} := q_{gwyn} \cdot 2 \cdot e_3$ $F_{UGWYn} = 0.66 kN$

$F_{UGWXc} := \gamma_{fw} \cdot F_{UGWXn}$ $F_{UGWXc} = 0.00 kN$ $F_{UGWYc} := \gamma_{fw} \cdot F_{UGWYn}$ $F_{UGWYc} = 0.92 kN$

Сеизмични сили/
Earthquake load:

$F_{UGEQXn} := a_h \cdot F_{UGZn}$ $F_{UGEQXn} = 0.91 kN$

$F_{UGEQYn} := a_h \cdot F_{UGZn}$ $F_{UGEQYn} = 0.91 kN$

$F_{UGEQZn} := a_v \cdot F_{UGZn}$ $F_{UGEQZn} = 0.91 kN$

ОПРЕДЕЛЯНЕ НА УСИЛИЯТА НА ГОРЕН РЪБ ФУНДАМЕНТ.

CALCULATION OF THE STRESS ON THE UPPER EDGE FOUNDATION.

A: Собствено тегло / Dead load:

нормативни натоварвания/normative loads

$F_{ZminAn} := \frac{F_{AZn} \cdot (2f_2 - 0.5f_1 - 0.5p_1) + F_{KZn} \cdot (f_2 - e_2 - 0.75f_1)}{f_2} + F_{UCZn} + \frac{F_{UGZn} \cdot (f_2 - e_3)}{f_2}$ $F_{ZminAn} = 3.44 kN$

$F_{ZmaxAn} := \frac{F_{AZn} \cdot (2p_1 + p_2 - f_2) + F_{KZn} \cdot (0.5f_2 + 0.25f_1 + e_2)}{f_2} + F_{UCZn} + \frac{F_{UGZn} \cdot e_3}{f_2}$ $F_{ZmaxAn} = 4.90 kN$

$F_{XAn} := 0.00 \cdot kN$ $M_{YAn} := 0$ $M_{YAn} = 0.00 kN \cdot m$

$F_{YAn} := 0.00 \cdot kN$ $M_{XAn} := 1.5F_{KZn} \cdot e_1$ $M_{XAn} = 0.34 kN \cdot m$

изчислителни натоварвания/calculating loads

$F_{ZminAc} := \frac{F_{AZc} \cdot (2f_2 - 0.5f_1 - 0.5p_1) + F_{KZc} \cdot (f_2 - e_2 - 0.75f_1)}{f_2} + F_{UCZc} + \frac{F_{UGZc} \cdot (f_2 - e_3)}{f_2}$ $F_{ZminAc} = 4.06 kN$

$F_{ZmaxAc} := \frac{F_{AZc} \cdot (2p_1 + p_2 - f_2) + F_{KZc} \cdot (0.5f_2 + 0.25f_1 + e_2)}{f_2} + F_{UCZc} + \frac{F_{UGZc} \cdot e_3}{f_2}$ $F_{ZmaxAc} = 5.67 kN$

$F_{XAc} := 0.00 \cdot kN$ $M_{YAc} := 0$ $M_{YAc} = 0.00 kN \cdot m$

$F_{YAc} := 0.00 \cdot kN$ $M_{XAc} := 1.5F_{KZc} \cdot e_1$ $M_{XAc} = 0.41 kN \cdot m$

C.1: Вятър по ос X / Windload direction X

нормативни натоварвания/normative loads

$F_{ZmaxC1n} := \frac{3F_{WXn} \cdot b}{f_2} + \frac{3F_{LXn} \cdot d}{f_2}$ $F_{ZmaxC1n} = 0.30 kN$

$F_{ZminC1n} := -F_{ZmaxC1n}$ $F_{ZminC1n} = -0.30 kN$

$F_{XC1n} := \frac{3}{2} \cdot F_{WXn} + F_{UCWXn} + \frac{3}{2} \cdot F_{LXn} + \frac{F_{UGWXn}}{2} + \frac{1.5F_{WKXn}}{2}$ $F_{XC1n} = 0.65 kN$

$M_{YC1n} := \frac{3}{2} \cdot F_{WXn} \cdot (n + b) + \frac{F_{UCWXn} \cdot n}{2} + \frac{3}{2} \cdot F_{LXn} \cdot (n + d) + \frac{F_{UGWXn} \cdot n}{2} + \frac{1.5F_{WKXn} \cdot p_3}{2}$ $M_{YC1n} = 1.39 kN \cdot m$

$F_{YC1n} := 0.00 \cdot kN$ $F_{YC1n} = 0.00 kN$

$M_{XC1n} := 0.00 \cdot kN \cdot m$ $M_{XC1n} = 0.00 kN \cdot m$

изчислителни натоварвания/calculating loads

$$F_{ZmaxC1c} := \frac{3F_{WXc} \cdot b}{f_2} + \frac{3F_{LXc} \cdot d}{f_2}$$

$$F_{ZmaxC1c} = 0.42 \text{ kN}$$

$$F_{ZminC1c} := -F_{ZmaxC1c}$$

$$F_{ZminC1c} = -0.42 \text{ kN}$$

$$F_{XC1c} := \frac{3}{2} \cdot F_{WXc} + F_{UCWXc} + \frac{3}{2} F_{LXc} + \frac{F_{UGWXc}}{2} + \frac{1.5F_{WKXc}}{2}$$

$$F_{XC1c} = 0.92 \text{ kN}$$

$$M_{YC1c} := \frac{3}{2} F_{WXc} \cdot (n + b) + \frac{F_{UCWXc} \cdot n}{2} + \frac{3}{2} F_{LXc} \cdot (n + d) + \frac{F_{UGWXc} \cdot n}{2} + \frac{1.5F_{WKXc} \cdot p_3}{2}$$

$$M_{YC1c} = 1.94 \text{ kN} \cdot \text{m}$$

$$F_{YC1c} := 0.00 \cdot \text{kN}$$

$$F_{YC1c} = 0.00 \text{ kN}$$

$$M_{XC1c} := 0.00 \cdot \text{kN} \cdot \text{m}$$

$$M_{XC1c} = 0.00 \text{ kN} \cdot \text{m}$$

C.2: Вятър по ос Y / Windload on direction Y

нормативни натоварвания/normative loads

$$F_{ZmaxC2n} := 0$$

$$F_{ZmaxC2n} = 0.00 \text{ kN}$$

$$F_{ZminC2n} := 0$$

$$F_{ZminC2n} = 0.00 \text{ kN}$$

$$F_{XC2n} := 0.00 \cdot \text{kN}$$

$$F_{XC2n} = 0.00 \text{ kN}$$

$$M_{YC2n} := 0.00 \cdot \text{kN} \cdot \text{m}$$

$$M_{YC2n} = 0.00 \text{ kN} \cdot \text{m}$$

$$F_{YC2n} := \frac{3}{2} F_{WYn} + F_{UCWYn} + \frac{3}{2} F_{LYn} + \frac{F_{UGWYn}}{2} + \frac{1.5F_{WKYn}}{2}$$

$$F_{YC2n} = 0.98 \text{ kN}$$

$$M_{XC2n} := \frac{3F_{WYn} \cdot (n + c)}{2} + \frac{F_{UCWYn} \cdot n}{2} + \frac{3F_{LYn} \cdot (n + d)}{2} + \frac{F_{UGWYn} \cdot n}{2} + \frac{1.5F_{WKYn} \cdot p_3}{2}$$

$$M_{XC2n} = 0.79 \text{ kN} \cdot \text{m}$$

изчислителни натоварвания/calculating loads

$$F_{ZmaxC2c} := 0$$

$$F_{ZmaxC2c} = 0.00 \text{ kN}$$

$$F_{ZminC2c} := 0$$

$$F_{ZminC2c} = 0.00 \text{ kN}$$

$$F_{XC2c} := 0.00 \cdot \text{kN}$$

$$F_{XC2c} = 0.00 \text{ kN}$$

$$M_{YC2c} := 0.00 \cdot \text{kN} \cdot \text{m}$$

$$M_{YC2c} = 0.00 \text{ kN} \cdot \text{m}$$

$$F_{YC2c} := \frac{3}{2} F_{WYc} + F_{UCWYc} + \frac{3}{2} F_{LYc} + \frac{F_{UGWYc}}{2} + \frac{1.5F_{WKYc}}{2}$$

$$F_{YC2c} = 1.38 \text{ kN}$$

$$M_{XC2c} := \frac{3F_{WYc} \cdot (n + c)}{2} + \frac{F_{UCWYc} \cdot n}{2} + \frac{3F_{LYc} \cdot (n + d)}{2} + \frac{F_{UGWYc} \cdot n}{2} + \frac{1.5F_{WKYc} \cdot p_3}{2}$$

$$M_{XC2c} = 1.10 \text{ kN} \cdot \text{m}$$

D: Опъвателна сила от проводник / Static conductor tension

нормативни натоварвания/normative loads

$$F_{ZmaxDn} := \frac{3 \cdot F_{SXn} \cdot d}{f_2}$$

$$F_{ZmaxDn} = 0.00 \text{ kN}$$

$$F_{ZminDn} := -F_{ZmaxDn}$$

$$F_{ZminDn} = 0.00 \text{ kN}$$

$$F_{XDn} := \frac{3F_{SXn}}{2}$$

$$F_{XDn} = 0.00 \text{ kN}$$

$$M_{YDn} := \frac{3F_{SXn} \cdot (n + d)}{2}$$

$$M_{YDn} = 0.00 \text{ kN} \cdot \text{m}$$

$$F_{YDn} := \frac{3}{2} F_{SYn}$$

$$F_{YDn} = 0.75 \text{ kN}$$

$$M_{XDn} := \frac{3 F_{SYn} \cdot (n + d)}{2}$$

$$M_{XDn} = 3.00 \text{ kN} \cdot \text{m}$$

изчислителни натоварвания/calculating loads

$$F_{ZmaxDc} := \frac{3 \cdot F_{SXc} \cdot d}{f_2}$$

$$F_{ZmaxDc} = 0.00 \text{ kN}$$

$$F_{ZminDc} := -F_{ZmaxDc}$$

$$F_{ZminDc} = 0.00 \text{ kN}$$

$$F_{XDc} := \frac{3 F_{SXc}}{2}$$

$$F_{XDc} = 0.00 \text{ kN}$$

$$M_{YDc} := \frac{3 F_{SXc} \cdot (n + d)}{2}$$

$$M_{YDc} = 0.00 \text{ kN} \cdot \text{m}$$

$$F_{YDc} := \frac{3}{2} F_{SYc}$$

$$F_{YDc} = 0.98 \text{ kN}$$

$$M_{XDc} := \frac{3 F_{SYc} \cdot (n + d)}{2}$$

$$M_{XDc} = 3.90 \text{ kN} \cdot \text{m}$$

Е: Късо съединение / Short-circuit forces

нормативни натоварвания/normative loads

$$F_{ZmaxEn} := 0$$

$$F_{ZmaxEn} = 0.00 \text{ kN}$$

$$F_{ZminEn} := 0$$

$$F_{ZminEn} = 0.00 \text{ kN}$$

$$F_{XEn} := F_{DXn} - F_{DXn}$$

$$F_{XEn} = 0.00 \text{ kN}$$

$$M_{YEn} := (F_{DXn} - F_{DXn}) \cdot (n + d)$$

$$M_{YEn} = 0.00 \text{ kN} \cdot \text{m}$$

$$F_{YEn} := \frac{F_{DYn}}{2}$$

$$F_{YEn} = 0.00 \text{ kN}$$

$$M_{XEn} := \frac{F_{DYn} \cdot (n + d)}{2}$$

$$M_{XEn} = 0.00 \text{ kN} \cdot \text{m}$$

Н: Монтажен товар / Erection load

нормативни натоварвания/normative loads

$$F_{ZmaxHn} := F_{MZn}$$

$$F_{ZmaxHn} = 1.00 \text{ kN}$$

$$F_{ZminHn} := 0.00 \cdot \text{kN}$$

$$F_{ZminHn} = 0.00 \text{ kN}$$

$$F_{XHn} := F_{MXn}$$

$$F_{XHn} = 1.00 \text{ kN}$$

$$M_{YHn} := F_{MXn} \cdot n$$

$$M_{YHn} = 2.35 \text{ kN} \cdot \text{m}$$

$$F_{YHn} := F_{MYn}$$

$$F_{YHn} = 1.00 \text{ kN}$$

$$M_{XHn} := F_{MYn} \cdot n$$

$$M_{XHn} = 2.35 \text{ kN} \cdot \text{m}$$

изчислителни натоварвания/calculating loads

$$F_{ZmaxHc} := F_{MZc}$$

$$F_{ZmaxHc} = 1.30 \text{ kN}$$

$$F_{ZminHc} := 0.00 \cdot \text{kN}$$

$$F_{ZminHc} = 0.00 \text{ kN}$$

$$F_{XHc} := F_{MXc}$$

$$F_{XHc} = 1.30 \text{ kN}$$

$$M_{YHc} := F_{MXc} \cdot n$$

$$M_{YHc} = 3.06 \text{ kN} \cdot \text{m}$$

$$F_{YHc} := F_{MYc}$$

$$F_{YHc} = 1.30 \text{ kN}$$

$$M_{XHc} := F_{MYc} \cdot n$$

$$M_{XHc} = 3.06 \text{ kN} \cdot \text{m}$$

F: Превключвателни сили / Switching forces

$$F_{ZmaxFn} := F_{CZmaxn} \quad \text{нормативни натоварвания/normative loads}$$

$$F_{ZmaxFn} = 0.00 \text{ kN}$$

$$F_{ZminFn} := F_{CZminn}$$

$$F_{ZminFn} = 0.00 \text{ kN}$$

$$F_{XFn} := F_{CXn}$$

$$F_{XFn} = 0.00 \text{ kN}$$

$$M_{YFn} := F_{CXn} \cdot n$$

$$M_{YFn} = 0.00 \text{ kN} \cdot \text{m}$$

$$F_{YFn} := F_{CYn}$$

$$F_{YFn} = 0.00 \text{ kN}$$

$$M_{XFn} := F_{CYn} \cdot n$$

$$M_{XFn} = 0.00 \text{ kN} \cdot \text{m}$$

G1: Земетръс по ос X / Earthquake load direction X

$$F_{ZmaxG1n} := \frac{3F_{EQXn} \cdot a}{f_2}$$

$$F_{ZmaxG1n} = 0.70 \text{ kN}$$

$$F_{ZminG1n} := -F_{ZmaxG1n}$$

$$F_{ZminG1n} = -0.70 \text{ kN}$$

$$F_{XG1n} := \frac{3}{2}F_{EQXn} + F_{UCEQXn} + \frac{F_{UGEQXn}}{2} + \frac{1.5F_{EQKXn}}{2}$$

$$F_{XG1n} = 1.77 \text{ kN}$$

$$M_{YG1n} := \frac{3}{2}F_{EQXn} \cdot (n + a) + F_{UCEQXn} \cdot \frac{n}{2} + \frac{F_{UGEQXn} \cdot n}{2} + \frac{1.5F_{EQKXn} \cdot p_3}{2}$$

$$M_{YG1n} = 4.49 \text{ kN} \cdot \text{m}$$

$$F_{YG1n} := 0.00 \cdot \text{kN}$$

$$F_{YG1n} = 0.00 \text{ kN}$$

$$M_{XG1n} := 0.00 \cdot \text{kN} \cdot \text{m}$$

$$M_{XG1n} = 0.00 \text{ kN} \cdot \text{m}$$

G2: Земетръс по ос Y / Earthquake load direction Y

$$F_{ZmaxG2n} := 0.00 \cdot \text{kN}$$

$$F_{ZmaxG2n} = 0.00 \text{ kN}$$

$$F_{ZminG2n} := 0.00 \cdot \text{kN}$$

$$F_{ZminG2n} = 0.00 \text{ kN}$$

$$F_{XG2n} := 0.00 \cdot \text{kN}$$

$$F_{XG2n} = 0.00 \text{ kN}$$

$$M_{YG2n} := 0.00 \cdot \text{kN} \cdot \text{m}$$

$$M_{YG2n} = 0.00 \text{ kN} \cdot \text{m}$$

$$F_{YG2n} := \frac{3}{2}F_{EQYn} + F_{UCEQYn} + \frac{F_{UGEQYn}}{2} + \frac{1.5F_{EQKYn}}{2}$$

$$F_{YG2n} = 1.77 \text{ kN}$$

$$M_{XG2n} := \frac{3}{2}F_{EQYn} \cdot (n + a) + F_{UCEQYn} \cdot \frac{n}{2} + \frac{F_{UGEQYn} \cdot n}{2} + \frac{1.5F_{EQKYn} \cdot p_3}{2}$$

$$M_{XG2n} = 4.49 \text{ kN} \cdot \text{m}$$

G3: Земетръс по ос Z / Earthquake load direction Z

нормативни натоварвания/normative loads

$$F_{ZminG3n} := \frac{F_{EQZn} \cdot (2f_2 - 0.5f_1 - 0.5p_1) + F_{EQKZn} \cdot (f_2 - e_2 - 0.75f_1)}{f_2} + F_{UCEQZn} + \frac{F_{UGEQZn} \cdot (f_2 - e_3)}{f_2}$$

$$F_{ZminG3n} = 1.15 \text{ kN}$$

$$F_{ZmaxG3n} := \frac{F_{EQZn} \cdot (2p_1 + p_2 - f_2) + F_{EQKZn} \cdot (0.5f_2 + 0.25f_1 + e_2)}{f_2} + F_{UCEQZn} + \frac{F_{UGEQZn} \cdot e_3}{f_2}$$

$$F_{ZmaxG3n} = 1.64 \text{ kN}$$

$$F_{XG3n} := 0.00 \cdot \text{kN} \quad M_{YG3n} := 0$$

$$M_{YG3n} = 0.00 \text{ kN} \cdot \text{m}$$

$$F_{YG3n} := 0.00 \cdot \text{kN} \quad M_{XG3n} := 1.5F_{EQKZn} \cdot e_1$$

$$M_{XG3n} = 0.11 \text{ kN} \cdot \text{m}$$

Комбинации от натоварванията/ Foundation loadcases
ОСНОВНИ КОМБИНАЦИИ/ NORMAL LOADCASES**Комбинация 1: Собствено тегло (A)/ Loadcase 1: Dead load (A)**

нормативни натоварвания/normative loads

$$\begin{aligned}
 F_{Zmax1n} &:= F_{ZmaxAn} & F_{Zmax1n} &= 4.90 \text{ kN} \\
 F_{Zmin1n} &:= F_{ZminAn} & F_{Zmin1n} &= 3.44 \text{ kN} \\
 F_{X1n} &:= F_{XAn} & F_{X1n} &= 0.00 \text{ kN} \\
 M_{Y1n} &:= M_{YAn} & M_{Y1n} &= 0.00 \text{ kN}\cdot\text{m} \\
 F_{Y1n} &:= F_{YAn} & F_{Y1n} &= 0.00 \text{ kN} \\
 M_{X1n} &:= M_{XAn} & M_{X1n} &= 0.34 \text{ kN}\cdot\text{m}
 \end{aligned}$$

изчислителни натоварвания/calculating loads

$$\begin{aligned}
 F_{Zmax1c} &:= F_{ZmaxAc} & F_{Zmax1c} &= 5.67 \text{ kN} \\
 F_{Zmin1c} &:= F_{ZminAc} & F_{Zmin1c} &= 4.06 \text{ kN} \\
 F_{X1c} &:= F_{XAc} & F_{X1c} &= 0.00 \text{ kN} \\
 M_{Y1c} &:= M_{YAc} & M_{Y1c} &= 0.00 \text{ kN}\cdot\text{m} \\
 F_{Y1c} &:= F_{YAc} & F_{Y1c} &= 0.00 \text{ kN} \\
 M_{X1c} &:= M_{XAc} & M_{X1c} &= 0.41 \text{ kN}\cdot\text{m}
 \end{aligned}$$

Комбинация 2: СТ(A)+Опъвателна сила от проводник(D)+Монтажен товар(H)
Loadcase CT(A)+ Static conductor tension (D)+ Erection load (H)

нормативни натоварвания/normative loads

$$\begin{aligned}
 F_{Zmax2n} &:= F_{ZmaxAn} + F_{ZmaxDn} + F_{ZmaxHn} & F_{Zmax2n} &= 5.90 \text{ kN} \\
 F_{Zmin2n} &:= F_{ZminAn} + F_{ZminDn} + F_{ZminHn} & F_{Zmin2n} &= 3.44 \text{ kN} \\
 F_{X2n} &:= F_{XAn} + F_{XDn} + F_{XHn} & F_{X2n} &= 1.00 \text{ kN} \\
 M_{Y2n} &:= M_{YAn} + M_{YDn} + M_{YHn} & M_{Y2n} &= 2.35 \text{ kN}\cdot\text{m} \\
 F_{Y2n} &:= F_{YAn} + F_{YDn} + F_{YHn} & F_{Y2n} &= 1.75 \text{ kN} \\
 M_{X2n} &:= M_{XAn} + M_{XDn} + M_{XHn} & M_{X2n} &= 5.69 \text{ kN}\cdot\text{m}
 \end{aligned}$$

изчислителни натоварвания/calculating loads

$$\begin{aligned}
 F_{Zmax2c} &:= F_{ZmaxAc} + F_{ZmaxDc} + F_{ZmaxHc} & F_{Zmax2c} &= 6.97 \text{ kN} \\
 F_{Zmin2c} &:= F_{ZminAc} + F_{ZminDc} + F_{ZminHc} & F_{Zmin2c} &= 4.06 \text{ kN} \\
 F_{X2c} &:= F_{XAc} + F_{XDc} + F_{XHc} & F_{X2c} &= 1.30 \text{ kN} \\
 M_{Y2c} &:= M_{YAc} + M_{YDc} + M_{YHc} & M_{Y2c} &= 3.06 \text{ kN}\cdot\text{m} \\
 F_{Y2c} &:= F_{YAc} + F_{YDc} + F_{YHc} & F_{Y2c} &= 2.28 \text{ kN} \\
 M_{X2c} &:= M_{XAc} + M_{XDc} + M_{XHc} & M_{X2c} &= 7.36 \text{ kN}\cdot\text{m}
 \end{aligned}$$

Комбинация 3: СТ(А)+Вятър по ос Х(С1)+Опъвателна сила от проводник(D)
Loadcase 3: СТ(А)+Wind direction X(C1)+Static conductor tension (D)

нормативни натоварвания/normative loads

$$\begin{aligned} F_{Zmax3n} &:= F_{ZmaxAn} + 0.9F_{ZmaxC1n} + 0.95F_{ZmaxDn} & F_{Zmax3n} &= 5.17 \text{ kN} \\ F_{Zmin3n} &:= F_{ZminAn} + 0.9F_{ZminC1n} + 0.95F_{ZminDn} & F_{Zmin3n} &= 3.17 \text{ kN} \\ F_{X3n} &:= F_{XAn} + 0.9F_{XC1n} + 0.95F_{XDn} & F_{X3n} &= 0.59 \text{ kN} \\ M_{Y3n} &:= M_{YAn} + 0.9M_{YC1n} + 0.95M_{YDn} & M_{Y3n} &= 1.25 \text{ kN}\cdot\text{m} \\ F_{Y3n} &:= F_{YAn} + 0.9F_{YC1n} + 0.95F_{YDn} & F_{Y3n} &= 0.71 \text{ kN} \\ M_{X3n} &:= M_{XAn} + 0.9M_{XC1n} + 0.95M_{XDn} & M_{X3n} &= 3.19 \text{ kN}\cdot\text{m} \end{aligned}$$

изчислителни натоварвания/calculating loads

$$\begin{aligned} F_{Zmax3c} &:= F_{ZmaxAc} + 0.9F_{ZmaxC1c} + 0.95F_{ZmaxDc} & F_{Zmax3c} &= 6.05 \text{ kN} \\ F_{Zmin3c} &:= F_{ZminAc} + 0.9F_{ZminC1c} + 0.95F_{ZminDc} & F_{Zmin3c} &= 3.68 \text{ kN} \\ F_{X3c} &:= F_{XAc} + 0.9F_{XC1c} + 0.95F_{XDc} & F_{X3c} &= 0.82 \text{ kN} \\ M_{Y3c} &:= M_{YAc} + 0.9M_{YC1c} + 0.95M_{YDc} & M_{Y3c} &= 1.75 \text{ kN}\cdot\text{m} \\ F_{Y3c} &:= F_{YAc} + 0.9F_{YC1c} + 0.95F_{YDc} & F_{Y3c} &= 0.93 \text{ kN} \\ M_{X3c} &:= M_{XAc} + 0.9M_{XC1c} + 0.95M_{XDc} & M_{X3c} &= 4.11 \text{ kN}\cdot\text{m} \end{aligned}$$

Комбинация 4: СТ(А)+Вятър по ос Y(C2)+Опъвателна сила от проводник(D)
Loadcase 4: СТ(А)+Wind direction Y(C2)+Static conductor tension (D)

нормативни натоварвания/normative loads

$$\begin{aligned} F_{Zmax4n} &:= F_{ZmaxAn} + 0.9F_{ZmaxC2n} + 0.95F_{ZmaxDn} & F_{Zmax4n} &= 4.90 \text{ kN} \\ F_{Zmin4n} &:= F_{ZminAn} + 0.9F_{ZminC2n} + 0.95F_{ZminDn} & F_{Zmin4n} &= 3.44 \text{ kN} \\ F_{X4n} &:= F_{XAn} + 0.9F_{XC2n} + 0.95F_{XDn} & F_{X4n} &= 0.00 \text{ kN} \\ M_{Y4n} &:= M_{YAn} + 0.9M_{YC2n} + 0.95M_{YDn} & M_{Y4n} &= 0.00 \text{ kN}\cdot\text{m} \\ F_{Y4n} &:= F_{YAn} + 0.9F_{YC2n} + 0.95F_{YDn} & F_{Y4n} &= 1.60 \text{ kN} \\ M_{X4n} &:= M_{XAn} + 0.9M_{XC2n} + 0.95M_{XDn} & M_{X4n} &= 3.90 \text{ kN}\cdot\text{m} \end{aligned}$$

изчислителни натоварвания/calculating loads

$$\begin{aligned} F_{Zmax4c} &:= F_{ZmaxAc} + 0.9F_{ZmaxC2c} + 0.95F_{ZmaxDc} & F_{Zmax4c} &= 5.67 \text{ kN} \\ F_{Zmin4c} &:= F_{ZminAc} + 0.9F_{ZminC2c} + 0.95F_{ZminDc} & F_{Zmin4c} &= 4.06 \text{ kN} \\ F_{X4c} &:= F_{XAc} + 0.9F_{XC2c} + 0.95F_{XDc} & F_{X4c} &= 0.00 \text{ kN} \\ M_{Y4c} &:= M_{YAc} + 0.9M_{YC2c} + 0.95M_{YDc} & M_{Y4c} &= 0.00 \text{ kN}\cdot\text{m} \\ F_{Y4c} &:= F_{YAc} + 0.9F_{YC2c} + 0.95F_{YDc} & F_{Y4c} &= 2.16 \text{ kN} \\ M_{X4c} &:= M_{XAc} + 0.9M_{XC2c} + 0.95M_{XDc} & M_{X4c} &= 5.11 \text{ kN}\cdot\text{m} \end{aligned}$$

ОСОБЕНИ КОМБИНАЦИИ/ EXCEPTIONAL LOADCASES

от нормативни натоварвания / from normative loads

Комбинация 5: СТ(А)+Късо съединение(Е) / Loadcase 5: СТ(А)+Short circuit forces

$$\begin{aligned} F_{Zmax5n} &:= F_{ZmaxAn} + F_{ZmaxEn} & F_{Zmax5n} &= 4.90 \text{ kN} \\ F_{Zmin5n} &:= F_{ZminAn} + F_{ZminEn} & F_{Zmin5n} &= 3.44 \text{ kN} \\ F_{X5n} &:= F_{XAn} + F_{XEn} & F_{X5n} &= 0.00 \text{ kN} \\ M_{Y5n} &:= M_{YAn} + M_{YEn} & M_{Y5n} &= 0.00 \text{ kN} \cdot \text{m} \\ F_{Y5n} &:= F_{YAn} + F_{YEn} & F_{Y5n} &= 0.00 \text{ kN} \\ M_{X5n} &:= M_{XAn} + M_{XEn} & M_{X5n} &= 0.34 \text{ kN} \cdot \text{m} \end{aligned}$$

Комбинация 6: СТ(А)+Опъвателна сила от проводник(Д)+Превключване(Ф) Loadcase 6: СТ(А)+Static conductor tension(Д)+Switching (F)

$$\begin{aligned} F_{Zmax6n} &:= F_{ZmaxAn} + 0.95F_{ZmaxDn} + F_{ZmaxFn} & F_{Zmax6n} &= 4.90 \text{ kN} \\ F_{Zmin6n} &:= F_{ZminAn} + 0.95F_{ZminDn} + F_{ZminFn} & F_{Zmin6n} &= 3.44 \text{ kN} \\ F_{X6n} &:= F_{XAn} + 0.95F_{XDn} + F_{XFn} & F_{X6n} &= 0.00 \text{ kN} \\ M_{Y6n} &:= M_{YAn} + 0.95M_{YDn} + M_{YFn} & M_{Y6n} &= 0.00 \text{ kN} \cdot \text{m} \\ F_{Y6n} &:= F_{YAn} + 0.95F_{YDn} + F_{YFn} & F_{Y6n} &= 0.71 \text{ kN} \\ M_{X6n} &:= M_{XAn} + 0.95M_{XDn} + M_{XFn} & M_{X6n} &= 3.19 \text{ kN} \cdot \text{m} \end{aligned}$$

Комбинация 7: СТ(А)+Опъвателна сила от проводник(Д)+Сеизмични сили по Х(Г.1)+/-Z(Г.3) Loadcase 7: СТ(А)+Static conductor tension(Д)+Earthquake load direction X(G.1)+/-Z(G.3)

$$\begin{aligned} F_{Zmax7n} &:= F_{ZmaxAn} + 0.95F_{ZmaxDn} + F_{ZmaxG1n} + F_{ZmaxG3n} & F_{Zmax7n} &= 7.23 \text{ kN} \\ F_{Zmin7n} &:= F_{ZminAn} + 0.95F_{ZminDn} + F_{ZminG1n} + F_{ZminG3n} & F_{Zmin7n} &= 3.89 \text{ kN} \\ F_{X7n} &:= F_{XAn} + 0.95F_{XDn} + F_{XG1n} + F_{XG3n} & F_{X7n} &= 1.77 \text{ kN} \\ M_{Y7n} &:= M_{YAn} + 0.95M_{YDn} + M_{YG1n} + M_{YG3n} & M_{Y7n} &= 4.49 \text{ kN} \cdot \text{m} \\ F_{Y7n} &:= F_{YAn} + 0.95F_{YDn} + F_{YG1n} + F_{YG3n} & F_{Y7n} &= 0.71 \text{ kN} \\ M_{X7n} &:= M_{XAn} + 0.95M_{XDn} + M_{XG1n} + M_{XG3n} & M_{X7n} &= 3.31 \text{ kN} \cdot \text{m} \end{aligned}$$

Комбинация 8: СТ(1)+Опъвателна сила от проводник(Д)+Сеизмични сили по Y(Г.2)+/-Z(Г.3) Loadcase 8: СТ(1)+Static conductor tension(Д)+Earthquake load direction Y(G.2)+/-Z(G.3)

$$\begin{aligned} F_{Zmax8n} &:= F_{ZmaxAn} + 0.95F_{ZmaxDn} + F_{ZmaxG2n} + F_{ZmaxG3n} & F_{Zmax8n} &= 6.53 \text{ kN} \\ F_{Zmin8n} &:= F_{ZminAn} + 0.95F_{ZminDn} + F_{ZminG2n} + F_{ZminG3n} & F_{Zmin8n} &= 4.59 \text{ kN} \\ F_{X8n} &:= F_{XAn} + 0.95F_{XDn} + F_{XG2n} + F_{XG3n} & F_{X8n} &= 0.00 \text{ kN} \\ M_{Y8n} &:= M_{YAn} + 0.95M_{YDn} + M_{YG2n} + M_{YG3n} & M_{Y8n} &= 0.00 \text{ kN} \cdot \text{m} \\ F_{Y8n} &:= F_{YAn} + 0.95F_{YDn} + F_{YG2n} + F_{YG3n} & F_{Y8n} &= 2.48 \text{ kN} \\ M_{X8n} &:= M_{XAn} + 0.95M_{XDn} + M_{XG2n} + M_{XG3n} & M_{X8n} &= 7.80 \text{ kN} \cdot \text{m} \end{aligned}$$

Комбинация 9.1: СТ(А)+Вятър по ос X(C.1)+Късо съединение (E)
Loadcase 9.1: CT(A)+Windload direction X(C.1)+Short-circuit forces (E)

$$F_{Zmax91n} := F_{ZmaxAn} + 0.8F_{ZmaxC1n} + F_{ZmaxEn}$$

$$F_{Zmax91n} = 5.14 \text{ kN}$$

$$F_{Zmin91n} := F_{ZminAn} + 0.8F_{ZminC1n} + F_{ZminEn}$$

$$F_{Zmin91n} = 3.20 \text{ kN}$$

$$F_{X91n} := F_{XAn} + 0.8F_{XC1n} + F_{XEn}$$

$$F_{X91n} = 0.52 \text{ kN}$$

$$M_{Y91n} := M_{YAn} + 0.8M_{YC1n} + M_{YEn}$$

$$M_{Y91n} = 1.11 \text{ kN}\cdot\text{m}$$

$$F_{Y91n} := F_{YAn} + 0.8F_{YC1n} + F_{YEn}$$

$$F_{Y91n} = 0.00 \text{ kN}$$

$$M_{X91n} := M_{XAn} + 0.8M_{XC1n} + M_{XEn}$$

$$M_{X91n} = 0.34 \text{ kN}\cdot\text{m}$$

Комбинация 9.2: СТ(А)+Вятър по ос Y(C.2)+Късо съединение (E)
Loadcase 9.2: CT(A)+Wind load direction Y(C.2)+Short-circuit forces (E)

$$F_{Zmax92n} := F_{ZmaxAn} + 0.8F_{ZmaxC2n} + F_{ZmaxEn}$$

$$F_{Zmax92n} = 4.90 \text{ kN}$$

$$F_{Zmin92n} := F_{ZminAn} + 0.8F_{ZminC2n} + F_{ZminEn}$$

$$F_{Zmin92n} = 3.44 \text{ kN}$$

$$F_{X92n} := F_{XAn} + 0.8F_{XC2n} + F_{XEn}$$

$$F_{X92n} = 0.00 \text{ kN}$$

$$M_{Y92n} := M_{YAn} + 0.8M_{YC2n} + M_{YEn}$$

$$M_{Y92n} = 0.00 \text{ kN}\cdot\text{m}$$

$$F_{Y92n} := F_{YAn} + 0.8F_{YC2n} + F_{YEn}$$

$$F_{Y92n} = 0.79 \text{ kN}$$

$$M_{X92n} := M_{XAn} + 0.8M_{XC2n} + M_{XEn}$$

$$M_{X92n} = 0.97 \text{ kN}\cdot\text{m}$$

Комбинация 10.1: СТ(А)+Сеизмични сили по оси X(G.1)+/-Z(G.3)
Loadcase 10.1: CT(A)+Earthquake load direction X(G.1)+/-Z(G.3)

$$F_{Zmax101n} := F_{ZmaxAn} + F_{ZmaxG1n} + F_{ZmaxG3n}$$

$$F_{Zmax101n} = 7.23 \text{ kN}$$

$$F_{Zmin101n} := F_{ZminAn} + F_{ZminG1n} + F_{ZminG3n}$$

$$F_{Zmin101n} = 3.89 \text{ kN}$$

$$F_{X101n} := F_{XAn} + F_{XG1n} + F_{XG3n}$$

$$F_{X101n} = 1.77 \text{ kN}$$

$$M_{Y101n} := M_{YAn} + M_{YG1n} + M_{YG3n}$$

$$M_{Y101n} = 4.49 \text{ kN}\cdot\text{m}$$

$$F_{Y101n} := F_{YAn} + F_{YG1n} + F_{YG3n}$$

$$F_{Y101n} = 0.00 \text{ kN}$$

$$M_{X101n} := M_{XAn} + M_{XG1n} + M_{XG3n}$$

$$M_{X101n} = 0.46 \text{ kN}\cdot\text{m}$$

Комбинация 10.2: СТ(А)+Сеизмични сили по ос Y(G.2)+/-Z(G.3)
Loadcase 10.2: CT(A)+Earthquake load direction Y(G.2)+/-Z(G.3)

$$F_{Zmax102n} := F_{ZmaxAn} + F_{ZmaxG2n} + F_{ZmaxG3n}$$

$$F_{Zmax102n} = 6.53 \text{ kN}$$

$$F_{Zmin102n} := F_{ZminAn} + F_{ZminG2n} + F_{ZminG3n}$$

$$F_{Zmin102n} = 4.59 \text{ kN}$$

$$F_{X102n} := F_{XAn} + F_{XG2n} + F_{XG3n}$$

$$F_{X102n} = 0.00 \text{ kN}$$

$$M_{Y102n} := M_{YAn} + M_{YG2n} + M_{YG3n}$$

$$M_{Y102n} = 0.00 \text{ kN}\cdot\text{m}$$

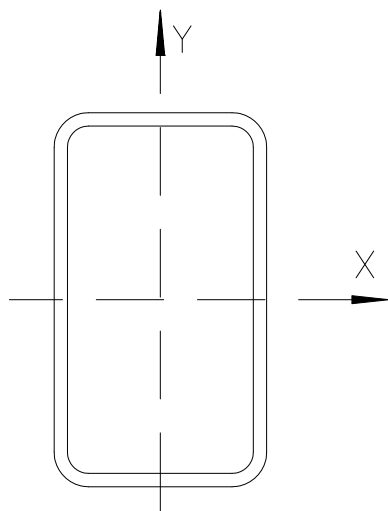
$$F_{Y102n} := F_{YAn} + F_{YG2n} + F_{YG3n}$$

$$F_{Y102n} = 1.77 \text{ kN}$$

$$M_{X102n} := M_{XAn} + M_{XG2n} + M_{XG3n}$$

$$M_{X102n} = 4.95 \text{ kN}\cdot\text{m}$$

Оразмеряване на стойката/Dimensioning of the stand



правоъгълна тръба/ rectangular tube **140.80.5 S235**

$a_c := 80\text{mm}$ $b_c := 140\text{mm}$

За съставеното сечение/for this section:

$J_x := 506\text{cm}^4$ $W_x := 72.4\cdot\text{cm}^3$ $i_x := 5.01\text{cm}$ $A_U := 20.1\cdot\text{cm}^2$

$J_y := 212\text{cm}^4$ $W_y := 53.1\cdot\text{cm}^3$ $i_y := 3.25\text{cm}$

коэффициент на изкълчване $\mu := 2.00$

Висоината на стойката и съоръжението $l_0 := n$ $l_0 = 2.35\text{ m}$

Изкълчвателната дължина $l_1 := \mu \cdot l_0$ $l_1 = 4.70\text{ m}$

Проверка на $\lambda := \frac{l_1}{i_y}$ $\lambda = 144.62$ $\lambda < \lambda_{rp} = 150$
стройността

коэффициентът на изкълчване $\phi := 0.3345$

Комбинация 2 / Loadcase 2:

$$f_{cL2} := \frac{M_{Y2c}}{W_y} + \frac{M_{X2c}}{W_x} + \frac{F_{Zmax2c}}{\phi \cdot A_U}$$

$$f_{cL2} = 169.62 \frac{\text{N}}{\text{mm}^2}$$

$$\frac{f_{cL2}}{f_{Sta24}} = 0.78 \quad \blacksquare < 1$$

Комбинация 3 / Loadcase 3:

$$f_{cL3} := \frac{M_{Y3c}}{W_y} + \frac{M_{X3c}}{W_x} + \frac{F_{Zmax3c}}{\phi \cdot A_U}$$

$$f_{cL3} = 98.74 \frac{\text{N}}{\text{mm}^2}$$

$$\frac{f_{cL3}}{f_{Sta24}} = 0.45 \quad \blacksquare < 1$$

Комбинация 4 / Loadcase 4:

$$f_{cL4} := \frac{M_{Y4c}}{W_y} + \frac{M_{X4c}}{W_x} + \frac{F_{Zmax4c}}{\phi \cdot A_U}$$

$$f_{cL4} = 78.96 \frac{\text{N}}{\text{mm}^2}$$

$$\frac{f_{cL4}}{f_{Sta24}} = 0.36 \quad \blacksquare < 1$$

Комбинация 5 / Loadcase 5:

$$f_{cL5} := \frac{M_{Y5n}}{W_y} + \frac{M_{X5n}}{W_x} + \frac{F_{Zmax5n}}{\phi \cdot A_U}$$

$$f_{cL5} = 12.00 \frac{\text{N}}{\text{mm}^2}$$

$$\frac{f_{cL5}}{f_{Sta24}} = 0.05 \quad \blacksquare < 1$$

Комбинация 6 / Loadcase 6:

$$f_{cL6} := \frac{M_{Y6n}}{W_y} + \frac{M_{X6n}}{W_x} + \frac{F_{Zmax6n}}{\phi \cdot A_U}$$

$$f_{cL6} = 51.36 \frac{\text{N}}{\text{mm}^2}$$

$$\frac{f_{cL6}}{f_{Sta24}} = 0.24 \quad \blacksquare < 1$$

Комбинация 7 / Loadcase 7:

$$f_{cL7} := \frac{M_{Y7n}}{W_y} + \frac{M_{X7n}}{W_x} + \frac{F_{Zmax7n}}{\phi \cdot A_U}$$

$$f_{cL7} = 141.02 \frac{\text{N}}{\text{mm}^2}$$

$$\frac{f_{cL7}}{f_{Sta24}} = 0.65 \quad \blacksquare < 1$$

Комбинация 8 / Loadcase 8:

$$f_{cL8} := \frac{M_{Y8n}}{W_y} + \frac{M_{X8n}}{W_x} + \frac{F_{Zmax8n}}{\phi \cdot A_U}$$

$$f_{cL8} = 117.43 \frac{\text{N}}{\text{mm}^2}$$

$$\frac{f_{cL8}}{f_{Sta24}} = 0.54 \quad \blacksquare < 1$$

Комбинация 9.1 / Loadcase 9.1:

$$f_{cL91} := \frac{M_{Y91n}}{W_y} + \frac{M_{X91n}}{W_x} + \frac{F_{Zmax91n}}{\phi \cdot A_U}$$

$$f_{cL91} = 33.25 \frac{\text{N}}{\text{mm}^2}$$

$$\frac{f_{cL91}}{f_{Sta24}} = 0.15 \quad \blacksquare < 1$$

Комбинация 9.2 / Loadcase 9.2:

$$f_{cL92} := \frac{M_{Y92n}}{W_y} + \frac{M_{X92n}}{W_x} + \frac{F_{Zmax92n}}{\phi \cdot A_U}$$

$$f_{cL92} = 20.69 \frac{N}{mm^2}$$

$$\frac{f_{cL92}}{f_{Sta24}} = 0.09 \quad \blacksquare < 1$$

Комбинация 10.1 / Loadcase 10.1:

$$f_{cL101} := \frac{M_{Y101n}}{W_y} + \frac{M_{X101n}}{W_x} + \frac{F_{Zmax101n}}{\phi \cdot A_U}$$

$$f_{cL101} = 101.66 \frac{N}{mm^2}$$

$$\frac{f_{cL101}}{f_{Sta24}} = 0.47 \quad \blacksquare < 1$$

Комбинация 10.2 / Loadcase 10.2:

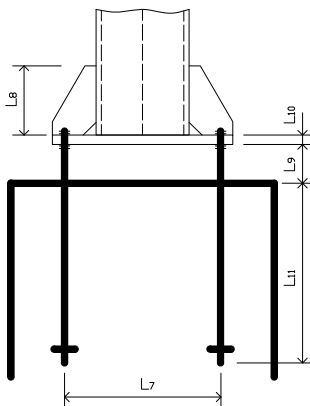
$$f_{cL102} := \frac{M_{Y102n}}{W_y} + \frac{M_{X102n}}{W_x} + \frac{F_{Zmax102n}}{\phi \cdot A_U}$$

$$f_{cL102} = 78.07 \frac{N}{mm^2}$$

$$\frac{f_{cL102}}{f_{Sta24}} = 0.36 \quad \blacksquare < 1$$

Заклучение: Всички напрежения са по-малки от $\sigma_{max} = 218.18 \text{ MPa}$

Conclusion: All stresses are lower than $\sigma_{max} = 218.18 \text{ MPa}$



избрани: **A4 Анкерни болтове M20 S355**

chosen: **A4 anchorbolts M20 S355**

$$l_7 := 300mm \quad l_8 := 250mm \quad l_9 := 100.00mm \quad l_{10} := 16mm$$

$$l_{11min} := 600mm \quad A_{b20} := 245mm^2 \quad W_{b20} := 540.9mm^3$$

$$f_{ta5.6} = 245.45 \frac{N}{mm^{2.00}}$$

Комбинация 2/ Loadcase 2:

**нормална сила/
normal force:**

$$N_{max2} := \frac{M_{X2c}}{2 \cdot l_7} + \frac{M_{Y2c}}{2l_7} + \frac{F_{Zmax2c}}{2 \cdot 2}$$

$$N_{max2} = 19.11 \text{ kN}$$

**срязваща сила/
shearing force:**

$$Q_{max2} := \sqrt{\left(\frac{F_{X2c}}{4}\right)^2 + \left(\frac{F_{Y2c}}{4}\right)^2}$$

$$Q_{max2} = 0.66 \text{ kN}$$

**огъващ момент/
bending moment:**

$$M_{max2} := Q_{max2} \cdot l_9 \cdot 0.5$$

$$M_{max2} = 0.03 \text{ kN} \cdot m$$

**напрежение на натиск/
compression stress:**

$$f_{cb2} := \frac{N_{max2}}{A_{b20}} + \frac{M_{max2}}{W_{b20}} \quad f_{cb2} = 138.55 \text{ MPa}$$

$$\frac{f_{cb2}}{f_{ta5.6}} = 0.56 \quad \blacksquare < 1$$

Комбинация 3/ Loadcase 3:

**нормална сила/
normal force:**

$$N_{max3} := \frac{M_{X3c}}{2l_7} + \frac{M_{Y3c}}{2 \cdot l_7} + \frac{F_{Zmax3c}}{2 \cdot 2}$$

$$N_{max3} = 11.28 \text{ kN}$$

**срязваща сила/
shearing force:**

$$Q_{max3} := \sqrt{\left(\frac{F_{X3c}}{4}\right)^2 + \left(\frac{F_{Y3c}}{4}\right)^2}$$

$$Q_{max3} = 0.31 \text{ kN}$$

**огъващ момент/
bending moment:**

$$M_{max3} := Q_{max3} \cdot l_9 \cdot 0.5$$

$$M_{max3} = 0.02 \text{ kN} \cdot m$$

**напрежение на натиск/
compression stress:**

$$f_{cb3} := \frac{N_{max3}}{A_{b20}} + \frac{M_{max3}}{W_{b20}} \quad f_{cb3} = 74.70 \text{ MPa}$$

$$\frac{f_{cb3}}{f_{ta5.6}} = 0.30 \quad \blacksquare < 1$$

Комбинация 4/ Loadcase 4:

нормална сила/
normal force:

$$N_{\max 4} := \frac{M_{X4c}}{2 \cdot l_7} + \frac{M_{Y4c}}{2 \cdot l_7} + \frac{F_{Z\max 4c}}{2 \cdot 2}$$

$$N_{\max 4} = 9.93 \text{ kN}$$

срязваща сила/
shearing force:

$$Q_{\max 4} := \sqrt{\left(\frac{F_{X4c}}{4}\right)^2 + \left(\frac{F_{Y4c}}{4}\right)^2}$$

$$Q_{\max 4} = 0.54 \text{ kN}$$

огъващ момент/
bending moment:

$$M_{\max 4} := Q_{\max 4} \cdot l_9 \cdot 0.5$$

$$M_{\max 4} = 0.03 \text{ kN} \cdot \text{m}$$

напрежение на натиск/
compression stress:

$$f_{cb4} := \frac{N_{\max 4}}{A_{b20}} + \frac{M_{\max 4}}{W_{b20}} \quad f_{cb4} = 90.55 \text{ MPa}$$

$$\frac{f_{cb4}}{f_{ta5.6}} = 0.37 \quad \blacksquare < 1$$

Комбинация 5/ Loadcase 5:

нормална сила/
normal force:

$$N_{\max 5} := \frac{M_{X5n}}{2 \cdot l_7} + \frac{M_{Y5n}}{2 \cdot l_7} + \frac{F_{Z\max 5n}}{2 \cdot 2}$$

$$N_{\max 5} = 1.79 \text{ kN}$$

срязваща сила/
shearing force:

$$Q_{\max 5} := \sqrt{\left(\frac{F_{X5n}}{4}\right)^2 + \left(\frac{F_{Y5n}}{4}\right)^2}$$

$$Q_{\max 5} = 0.00 \text{ kN}$$

огъващ момент/
bending moment:

$$M_{\max 5} := Q_{\max 5} \cdot l_9 \cdot 0.5$$

$$M_{\max 5} = 0.00 \text{ kN} \cdot \text{m}$$

напрежение на натиск/
compression stress:

$$f_{cb5} := \frac{N_{\max 5}}{A_{b20}} + \frac{M_{\max 5}}{W_{b20}} \quad f_{cb5} = 7.32 \text{ MPa}$$

$$\frac{f_{cb5}}{f_{ta5.6}} = 0.03 \quad \blacksquare < 1$$

Комбинация 6/ Loadcase 6:

нормална сила/
normal force:

$$N_{\max 6} := \frac{M_{X6n}}{2 \cdot l_7} + \frac{M_{Y6n}}{2 \cdot l_7} + \frac{F_{Z\max 6n}}{2 \cdot 2}$$

$$N_{\max 6} = 6.54 \text{ kN}$$

срязваща сила/
shearing force:

$$Q_{\max 6} := \sqrt{\left(\frac{F_{X6n}}{4}\right)^2 + \left(\frac{F_{Y6n}}{4}\right)^2}$$

$$Q_{\max 6} = 0.18 \text{ kN}$$

огъващ момент/
bending moment:

$$M_{\max 6} := Q_{\max 6} \cdot l_9 \cdot 0.5$$

$$M_{\max 6} = 0.00 \text{ kN} \cdot \text{m}$$

напрежение на натиск/
compression stress:

$$f_{cb6} := \frac{N_{\max 6}}{A_{b20}} + \frac{M_{\max 6}}{W_{b20}} \quad f_{cb6} = 26.71 \text{ MPa}$$

$$\frac{f_{cb6}}{f_{ta5.6}} = 0.11 \quad \blacksquare < 1$$

Комбинация 7/ Loadcase 7:

нормална сила/
normal force:

$$N_{\max 7} := \frac{M_{X7n}}{2 \cdot l_7} + \frac{M_{Y7n}}{2 \cdot l_7} + \frac{F_{Z\max 7n}}{2 \cdot 2}$$

$$N_{\max 7} = 14.81 \text{ kN}$$

срязваща сила/
shearing force:

$$Q_{\max 7} := \sqrt{\left(\frac{F_{X7n}}{4}\right)^2 + \left(\frac{F_{Y7n}}{4}\right)^2}$$

$$Q_{\max 7} = 0.48 \text{ kN}$$

огъващ момент/
bending moment:

$$M_{\max 7} := Q_{\max 7} \cdot l_9 \cdot 0.5$$

$$M_{\max 7} = 0.02 \text{ kN} \cdot \text{m}$$

напрежение на натиск/
compression stress:

$$f_{cb7} := \frac{N_{\max 7}}{A_{b20}} + \frac{M_{\max 7}}{W_{b20}} \quad f_{cb7} = 104.43 \text{ MPa}$$

$$\frac{f_{cb7}}{f_{ta5.6}} = 0.43 \quad \blacksquare < 1$$

Комбинация 8/ Loadcase 8:

нормална сила/
normal force:

$$N_{\max 8} := \frac{M_{X8n}}{2l_7} + \frac{M_{Y8n}}{2 \cdot l_7} + \frac{F_{Z\max 8n}}{2 \cdot 2}$$

$$N_{\max 8} = 14.63 \text{ kN}$$

срязваща сила/
shearing force:

$$Q_{\max 8} := \sqrt{\left(\frac{F_{X8n}}{4}\right)^2 + \left(\frac{F_{Y8n}}{4}\right)^2}$$

$$Q_{\max 8} = 0.62 \text{ kN}$$

огъващ момент/
bending moment:

$$M_{\max 8} := Q_{\max 8} \cdot l_9 \cdot 0.5$$

$$M_{\max 8} = 0.03 \text{ kN} \cdot \text{m}$$

напрежение на натиск/
compression stress:

$$f_{cb8} := \frac{N_{\max 8}}{A_{b20}} + \frac{M_{\max 8}}{W_{b20}} \quad f_{cb8} = 116.99 \text{ MPa}$$

$$\frac{f_{cb8}}{f_{ta5.6}} = 0.48 \quad \blacksquare < 1$$

Комбинация 9.1/ Loadcase 9.1:

нормална сила/
normal force:

$$N_{\max 91} := \frac{M_{X91n}}{2l_7} + \frac{M_{Y91n}}{2 \cdot l_7} + \frac{F_{Z\max 91n}}{2 \cdot 2}$$

$$N_{\max 91} = 3.70 \text{ kN}$$

срязваща сила/
shearing force:

$$Q_{\max 91} := \sqrt{\left(\frac{F_{X91n}}{4}\right)^2 + \left(\frac{F_{Y91n}}{4}\right)^2}$$

$$Q_{\max 91} = 0.13 \text{ kN}$$

огъващ момент/
bending moment:

$$M_{\max 91} := Q_{\max 91} \cdot l_9 \cdot 0.5$$

$$M_{\max 91} = 6.54 \times 10^{-3} \text{ kN} \cdot \text{m}$$

напрежение на натиск/
compression stress:

$$f_{cb91} := \frac{N_{\max 91}}{A_{b20}} + \frac{M_{\max 91}}{W_{b20}} \quad f_{cb91} = 27.20 \text{ MPa}$$

$$\frac{f_{cb91}}{f_{ta5.6}} = 0.11 \quad \blacksquare < 1$$

Комбинация 9.2/ Loadcase 9.2:

нормална сила/
normal force:

$$N_{\max 92} := \frac{M_{X92n}}{2l_7} + \frac{M_{Y92n}}{2 \cdot l_7} + \frac{F_{Z\max 92n}}{2 \cdot 2}$$

$$N_{\max 92} = 2.84 \text{ kN}$$

срязваща сила/
shearing force:

$$Q_{\max 92} := \sqrt{\left(\frac{F_{X92n}}{4}\right)^2 + \left(\frac{F_{Y92n}}{4}\right)^2}$$

$$Q_{\max 92} = 0.20 \text{ kN}$$

огъващ момент/
bending moment:

$$M_{\max 92} := Q_{\max 92} \cdot l_9 \cdot 0.5$$

$$M_{\max 92} = 9.83 \times 10^{-3} \text{ kN} \cdot \text{m}$$

напрежение на натиск/
compression stress:

$$f_{cb92} := \frac{N_{\max 92}}{A_{b20}} + \frac{M_{\max 92}}{W_{b20}} \quad f_{cb92} = 29.78 \text{ MPa}$$

$$\frac{f_{cb92}}{f_{ta5.6}} = 0.12 \quad \blacksquare < 1$$

Комбинация 10.1/ Loadcase 10.1:

нормална сила/
normal force:

$$N_{\max 101} := \frac{M_{X101n}}{2l_7} + \frac{M_{Y101n}}{2 \cdot l_7} + \frac{F_{Z\max 101n}}{2 \cdot 2}$$

$$N_{\max 101} = 10.06 \text{ kN}$$

срязваща сила/
shearing force:

$$Q_{\max 101} := \sqrt{\left(\frac{F_{X101n}}{4}\right)^2 + \left(\frac{F_{Y101n}}{4}\right)^2}$$

$$Q_{\max 101} = 0.44 \text{ kN}$$

огъващ момент/
bending moment:

$$M_{\max 101} := Q_{\max 101} \cdot l_9 \cdot 0.5$$

$$M_{\max 101} = 0.02 \text{ kN} \cdot \text{m}$$

напрежение на натиск/
compression stress:

$$f_{cb101} := \frac{N_{\max 101}}{A_{b20}} + \frac{M_{\max 101}}{W_{b20}} \quad f_{cb101} = 81.85 \text{ MPa}$$

$$\frac{f_{cb101}}{f_{ta5.6}} = 0.33 \quad \blacksquare < 1$$

Комбинация 10.2/ Loadcase 10.2:

**нормална сила/
normal force:**

$$N_{\max 102} := \frac{M_{X102n}}{2l_7} + \frac{M_{Y102n}}{2 \cdot l_7} + \frac{F_{Z\max 102n}}{2 \cdot 2}$$

$$N_{\max 102} = 9.88 \text{ kN}$$

**срязваща сила/
shearing force:**

$$Q_{\max 102} := \sqrt{\left(\frac{F_{X102n}}{4}\right)^2 + \left(\frac{F_{Y102n}}{4}\right)^2}$$

$$Q_{\max 102} = 0.44 \text{ kN}$$

**огъващ момент/
bending moment:**

$$M_{\max 102} := Q_{\max 102} \cdot l_9 \cdot 0.5$$

$$M_{\max 102} = 0.02 \text{ kN} \cdot \text{m}$$

**напрежение на натиск/
compression stress:**

$$f_{cb102} := \frac{N_{\max 102}}{A_{b20}} + \frac{M_{\max 102}}{W_{b20}} \quad f_{cb102} = 81.14 \text{ MPa}$$

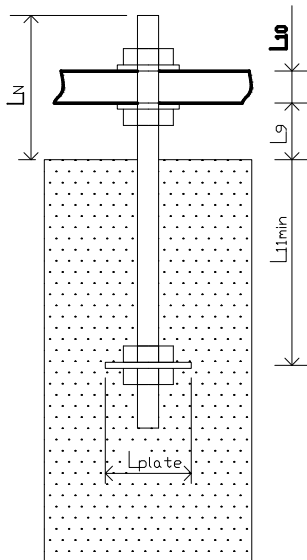
$$\frac{f_{cb102}}{f_{ta5.6}} = 0.33 \quad \blacksquare < 1$$

Анкерни планки/ Anchor plates pl. 10/100x100

$$l_{plate} := 100.00 \text{ mm} \quad l_{11min} = 0.60 \text{ m}$$

напрежение на натиск/ срязваща сила бетон **B20**
compression stress/ shearing stress concrete **B20**

$$f_{conpa} := 12.3 \cdot \frac{N}{\text{mm}^2} \quad f_{consa} := 1.80 \cdot \frac{N}{\text{mm}^2}$$



Комбинация 2/ Loadcase 2:

$$f_{comp2} := \frac{N_{\max 2}}{l_{plate}^2 - A_{b20}} \quad f_{comp2} = 1.96 \text{ MPa}$$

$$\frac{f_{comp2}}{f_{conpa}} = 0.16 \quad \blacksquare < 1$$

$$f_{cons2} := \frac{N_{\max 2}}{4 \cdot l_{plate} \cdot l_{11min}} \quad f_{cons2} = 0.08 \text{ MPa}$$

$$\frac{f_{cons2}}{f_{consa}} = 0.04 \quad \blacksquare < 1$$

Комбинация 3/ Loadcase 3:

$$f_{comp3} := \frac{N_{\max 3}}{l_{plate}^2 - A_{b20}} \quad f_{comp3} = 1.16 \text{ MPa}$$

$$\frac{f_{comp3}}{f_{conpa}} = 0.09 \quad \blacksquare < 1$$

$$f_{cons3} := \frac{N_{\max 3}}{4 \cdot l_{plate} \cdot l_{11min}} \quad f_{cons3} = 0.05 \text{ MPa}$$

$$\frac{f_{cons3}}{f_{consa}} = 0.03 \quad \blacksquare < 1$$

Комбинация 4/ Loadcase 4:

$$f_{comp4} := \frac{N_{\max 4}}{l_{plate}^2 - A_{b20}} \quad f_{comp4} = 1.02 \text{ MPa}$$

$$\frac{f_{comp4}}{f_{conpa}} = 0.08 \quad \blacksquare < 1$$

$$f_{cons4} := \frac{N_{\max 4}}{4 \cdot l_{plate} \cdot l_{11min}} \quad f_{cons4} = 0.04 \text{ MPa}$$

$$\frac{f_{cons4}}{f_{consa}} = 0.02 \quad \blacksquare < 1$$

Комбинация 5/ Loadcase 5:

$$f_{comp5} := \frac{N_{\max 5}}{l_{plate}^2 - A_{b20}} \quad f_{comp5} = 0.18 \text{ MPa}$$

$$\frac{f_{comp5}}{f_{conpa}} = 0.01 \quad \blacksquare < 1$$

$$f_{cons5} := \frac{N_{\max 5}}{4 \cdot l_{plate} \cdot l_{11min}} \quad f_{cons5} = 7.47 \times 10^{-3} \text{ MPa}$$

$$\frac{f_{cons5}}{f_{consa}} = 4.15 \times 10^{-3} \quad \blacksquare < 1$$

Комбинация 7/ Loadcase 7:

$$f_{\text{comp7}} := \frac{N_{\text{max7}}}{l_{\text{plate}}^2 - A_{\text{b20}}} \quad f_{\text{comp7}} = 1.52 \text{ MPa}$$

$$\frac{f_{\text{comp7}}}{f_{\text{conpa}}} = 0.12 \quad \blacksquare < 1$$

$$f_{\text{cons7}} := \frac{N_{\text{max7}}}{4 \cdot l_{\text{plate}} \cdot l_{11\text{min}}} \quad f_{\text{cons7}} = 0.06 \text{ MPa}$$

$$\frac{f_{\text{cons7}}}{f_{\text{consa}}} = 0.03 \quad \blacksquare < 1$$

Комбинация 8/ Loadcase 8:

$$f_{\text{comp8}} := \frac{N_{\text{max8}}}{l_{\text{plate}}^2 - A_{\text{b20}}} \quad f_{\text{comp8}} = 1.50 \text{ MPa}$$

$$\frac{f_{\text{comp8}}}{f_{\text{conpa}}} = 0.12 \quad \blacksquare < 1$$

$$f_{\text{cons8}} := \frac{N_{\text{max8}}}{4 \cdot l_{\text{plate}} \cdot l_{11\text{min}}} \quad f_{\text{cons8}} = 0.06 \text{ MPa}$$

$$\frac{f_{\text{cons8}}}{f_{\text{consa}}} = 0.03 \quad \blacksquare < 1$$

Комбинация 9.1/ Loadcase 9.1:

$$f_{\text{comp91}} := \frac{N_{\text{max91}}}{l_{\text{plate}}^2 - A_{\text{b20}}} \quad f_{\text{comp91}} = 0.38 \text{ MPa}$$

$$\frac{f_{\text{comp91}}}{f_{\text{conpa}}} = 0.03 \quad \blacksquare < 1$$

$$f_{\text{cons91}} := \frac{N_{\text{max91}}}{4 \cdot l_{\text{plate}} \cdot l_{11\text{min}}} \quad f_{\text{cons91}} = 0.02 \text{ MPa}$$

$$\frac{f_{\text{cons91}}}{f_{\text{consa}}} = 8.57 \times 10^{-2} \quad \blacksquare < 1$$

Комбинация 9.2/ Loadcase 9.2:

$$f_{\text{comp92}} := \frac{N_{\text{max92}}}{l_{\text{plate}}^2 - A_{\text{b20}}} \quad f_{\text{comp92}} = 0.29 \text{ MPa}$$

$$\frac{f_{\text{comp92}}}{f_{\text{conpa}}} = 0.02 \quad \blacksquare < 1$$

$$f_{\text{cons92}} := \frac{N_{\text{max92}}}{4 \cdot l_{\text{plate}} \cdot l_{11\text{min}}} \quad f_{\text{cons92}} = 0.01 \text{ MPa}$$

$$\frac{f_{\text{cons92}}}{f_{\text{consa}}} = 6.58 \times 10^{-2} \quad \blacksquare < 1$$

Комбинация 10.1/ Loadcase 10.1:

$$f_{\text{comp101}} := \frac{N_{\text{max101}}}{l_{\text{plate}}^2 - A_{\text{b20}}} \quad f_{\text{comp101}} = 1.03 \text{ MPa}$$

$$\frac{f_{\text{comp101}}}{f_{\text{conpa}}} = 0.08 \quad \blacksquare < 1$$

$$f_{\text{cons101}} := \frac{N_{\text{max101}}}{4 \cdot l_{\text{plate}} \cdot l_{11\text{min}}} \quad f_{\text{cons101}} = 0.04 \text{ MPa}$$

$$\frac{f_{\text{cons101}}}{f_{\text{consa}}} = 0.02 \quad \blacksquare < 1$$

Комбинация 10.2/ Loadcase 10.2:

$$f_{\text{comp102}} := \frac{N_{\text{max102}}}{l_{\text{plate}}^2 - A_{\text{b20}}} \quad f_{\text{comp102}} = 1.01 \text{ MPa}$$

$$\frac{f_{\text{comp102}}}{f_{\text{conpa}}} = 0.08 \quad \blacksquare < 1$$

$$f_{\text{cons102}} := \frac{N_{\text{max102}}}{4 \cdot l_{\text{plate}} \cdot l_{11\text{min}}} \quad f_{\text{cons102}} = 0.04 \text{ MPa}$$

$$\frac{f_{\text{cons102}}}{f_{\text{consa}}} = 0.02 \quad \blacksquare < 1$$

Планки/ Plates pl. 6/200x120 S235 $b_c = 140.00 \text{ mm}$ $l_g = 250.00 \text{ mm}$ $t_r := 6 \cdot \text{mm}$

$$l_{\text{supportingY}} := (l_7 - b_c) \cdot 0.5$$

$$l_{\text{supportingY}} = 80.00 \text{ mm}$$

$$l_{\text{bolt}} := 20 \cdot \text{mm}$$

$$W_r := \frac{l_g^2 \cdot t_r}{6}$$

$$W_r = 6.25 \times 10^4 \text{ mm}^3$$

Комбинация 2/ Loadcase 2:

$$f_{tr2} := \frac{N_{\text{max2}} \cdot l_{\text{supportingY}}}{W_r}$$

$$f_{tr2} = 24.46 \frac{\text{N}}{\text{mm}^2}$$

$$\frac{f_{tr2}}{f_{\text{Sta24}}} = 0.11$$

■ < 1

Комбинация 3/ Loadcase 3:

$$f_{tr3} := \frac{N_{\text{max3}} \cdot l_{\text{supportingY}}}{W_r}$$

$$f_{tr3} = 14.44 \frac{\text{N}}{\text{mm}^2}$$

$$\frac{f_{tr3}}{f_{\text{Sta24}}} = 0.07$$

■ < 1

Комбинация 4/ Loadcase 4:

$$f_{tr4} := \frac{N_{\text{max4}} \cdot l_{\text{supportingY}}}{W_r}$$

$$f_{tr4} = 12.71 \frac{\text{N}}{\text{mm}^2}$$

$$\frac{f_{tr4}}{f_{\text{Sta24}}} = 0.06$$

■ < 1

Комбинация 5/ Loadcase 5:

$$f_{tr5} := \frac{N_{\text{max5}} \cdot l_{\text{supportingY}}}{W_r}$$

$$f_{tr5} = 2.30 \frac{\text{N}}{\text{mm}^2}$$

$$\frac{f_{tr5}}{f_{\text{Sta24}}} = 0.01$$

■ < 1

Комбинация 6/ Loadcase 6:

$$f_{tr6} := \frac{N_{\text{max6}} \cdot l_{\text{supportingY}}}{W_r}$$

$$f_{tr6} = 8.38 \frac{\text{N}}{\text{mm}^2}$$

$$\frac{f_{tr6}}{f_{\text{Sta24}}} = 0.04$$

■ < 1

Комбинация 7/ Loadcase 7:

$$f_{tr7} := \frac{N_{\text{max7}} \cdot l_{\text{supportingY}}}{W_r}$$

$$f_{tr7} = 18.95 \frac{\text{N}}{\text{mm}^2}$$

$$\frac{f_{tr7}}{f_{\text{Sta24}}} = 0.09$$

■ < 1

Комбинация 8/ Loadcase 8:

$$f_{tr8} := \frac{N_{\text{max8}} \cdot l_{\text{supportingY}}}{W_r}$$

$$f_{tr8} = 18.73 \frac{\text{N}}{\text{mm}^2}$$

$$\frac{f_{tr8}}{f_{\text{Sta24}}} = 0.09$$

■ < 1

Комбинация 9.1/ Loadcase 9.1:

$$f_{tr91} := \frac{N_{\text{max91}} \cdot l_{\text{supportingY}}}{W_r}$$

$$f_{tr91} = 4.74 \frac{\text{N}}{\text{mm}^2}$$

$$\frac{f_{tr91}}{f_{\text{Sta24}}} = 0.02$$

■ < 1

Комбинация 9.2/ Loadcase 9.2:

$$f_{tr92} := \frac{N_{\text{max92}} \cdot l_{\text{supportingY}}}{W_r}$$

$$f_{tr92} = 3.64 \frac{\text{N}}{\text{mm}^2}$$

$$\frac{f_{tr92}}{f_{\text{Sta24}}} = 0.02$$

■ < 1

Комбинация 10.1/ Loadcase 10.1:

$$f_{tr101} := \frac{N_{\text{max101}} \cdot l_{\text{supportingY}}}{W_r}$$

$$f_{tr101} = 12.87 \frac{\text{N}}{\text{mm}^2}$$

$$\frac{f_{tr101}}{f_{\text{Sta24}}} = 0.06$$

■ < 1

Комбинация 10.2/ Loadcase 10.2:

$$f_{tr102} := \frac{N_{\text{max102}} \cdot l_{\text{supportingY}}}{W_r}$$

$$f_{tr102} = 12.65 \frac{\text{N}}{\text{mm}^2}$$

$$\frac{f_{tr102}}{f_{\text{Sta24}}} = 0.06$$

■ < 1

Опорна планка/ Supporting plate

pl. 16/420x420 S335

$l_{10} = 16.00 \text{ mm}$

$$l_{\text{suppY}} := (l_7 - a_c) \cdot 0.5 + 20 \cdot \text{mm} \quad l_{\text{suppY}} = 130.00 \text{ mm} \quad l_{\text{bolt}} = 20.00 \text{ mm} \quad W_{\text{pl}} := \frac{l_{10}^2}{6} (2 \cdot l_{\text{suppY}} + l_{\text{bolt}}) \quad W_{\text{pl}} = 1.19 \times 10^4 \text{ mm}^3$$

Комбинация 2/ Loadcase 2:

$$f_{\text{tGp2}} := \frac{N_{\text{max2}} \cdot l_{\text{suppY}}}{W_{\text{pl}}} \quad f_{\text{tGp2}} = 207.94 \frac{\text{N}}{\text{mm}^2} \quad \frac{f_{\text{tGp2}}}{f_{\text{Sta36}}} = 0.64 \quad \blacksquare < 1$$

Комбинация 3/ Loadcase 3:

$$f_{\text{tGp3}} := \frac{N_{\text{max3}} \cdot l_{\text{suppY}}}{W_{\text{pl}}} \quad f_{\text{tGp3}} = 122.77 \frac{\text{N}}{\text{mm}^2} \quad \frac{f_{\text{tGp3}}}{f_{\text{Sta36}}} = 0.38 \quad \blacksquare < 1$$

Комбинация 4/ Loadcase 4:

$$f_{\text{tGp4}} := \frac{N_{\text{max4}} \cdot l_{\text{suppY}}}{W_{\text{pl}}} \quad f_{\text{tGp4}} = 108.03 \frac{\text{N}}{\text{mm}^2} \quad \frac{f_{\text{tGp4}}}{f_{\text{Sta36}}} = 0.33 \quad \blacksquare < 1$$

Комбинация 5/ Loadcase 5:

$$f_{\text{tGp5}} := \frac{N_{\text{max5}} \cdot l_{\text{suppY}}}{W_{\text{pl}}} \quad f_{\text{tGp5}} = 19.51 \frac{\text{N}}{\text{mm}^2} \quad \frac{f_{\text{tGp5}}}{f_{\text{Sta36}}} = 0.06 \quad \blacksquare < 1$$

Комбинация 6/ Loadcase 6:

$$f_{\text{tGp6}} := \frac{N_{\text{max6}} \cdot l_{\text{suppY}}}{W_{\text{pl}}} \quad f_{\text{tGp6}} = 71.20 \frac{\text{N}}{\text{mm}^2} \quad \frac{f_{\text{tGp6}}}{f_{\text{Sta36}}} = 0.22 \quad \blacksquare < 1$$

Комбинация 7/ Loadcase 7:

$$f_{\text{tGp7}} := \frac{N_{\text{max7}} \cdot l_{\text{suppY}}}{W_{\text{pl}}} \quad f_{\text{tGp7}} = 161.11 \frac{\text{N}}{\text{mm}^2} \quad \frac{f_{\text{tGp7}}}{f_{\text{Sta36}}} = 0.49 \quad \blacksquare < 1$$

Комбинация 8/ Loadcase 8:

$$f_{\text{tGp8}} := \frac{N_{\text{max8}} \cdot l_{\text{suppY}}}{W_{\text{pl}}} \quad f_{\text{tGp8}} = 159.21 \frac{\text{N}}{\text{mm}^2} \quad \frac{f_{\text{tGp8}}}{f_{\text{Sta36}}} = 0.49 \quad \blacksquare < 1$$

Комбинация 9.1/ Loadcase 9.1:

$$f_{\text{tGp91}} := \frac{N_{\text{max91}} \cdot l_{\text{suppY}}}{W_{\text{pl}}} \quad f_{\text{tGp91}} = 40.29 \frac{\text{N}}{\text{mm}^2} \quad \frac{f_{\text{tGp91}}}{f_{\text{Sta36}}} = 0.12 \quad \blacksquare < 1$$

Комбинация 9.2/ Loadcase 9.2:

$$f_{\text{tGp92}} := \frac{N_{\text{max92}} \cdot l_{\text{suppY}}}{W_{\text{pl}}} \quad f_{\text{tGp92}} = 30.93 \frac{\text{N}}{\text{mm}^2} \quad \frac{f_{\text{tGp92}}}{f_{\text{Sta36}}} = 0.09 \quad \blacksquare < 1$$

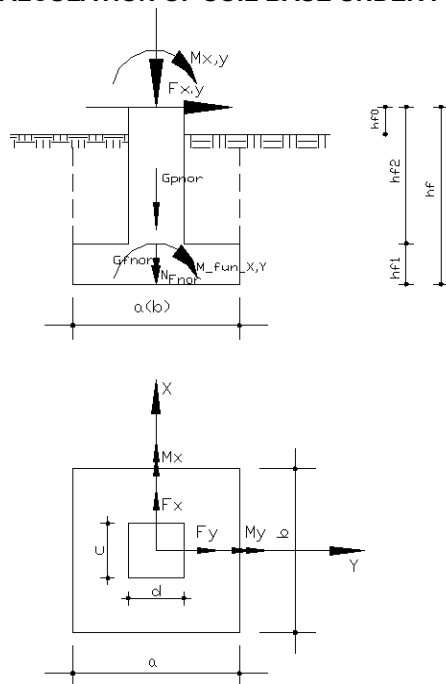
Комбинация 10.1/ Loadcase 10.1:

$$f_{\text{tGp101}} := \frac{N_{\text{max101}} \cdot l_{\text{suppY}}}{W_{\text{pl}}} \quad f_{\text{tGp101}} = 109.42 \frac{\text{N}}{\text{mm}^2} \quad \frac{f_{\text{tGp101}}}{f_{\text{Sta36}}} = 0.33 \quad \blacksquare < 1$$

Комбинация 10.2/ Loadcase 10.2:

$$f_{\text{tGp102}} := \frac{N_{\text{max102}} \cdot l_{\text{suppY}}}{W_{\text{pl}}} \quad f_{\text{tGp102}} = 107.52 \frac{\text{N}}{\text{mm}^2} \quad \frac{f_{\text{tGp102}}}{f_{\text{Sta36}}} = 0.33 \quad \blacksquare < 1$$

ПРОВЕРКА НА ЗЕМНАТА ОСНОВА ПОД ФУНДАМЕНТ
CALCULATION OF SOIL BASE UNDER FOUNDATION



Входни данни за усилията на горен ръб фундамент, съгласно Табл. 2

Input data for the stress on upper edge foundation, acc.to Table 2

$$\begin{aligned}
 F_{X_1.5} &:= \begin{pmatrix} F_{X1n} \\ F_{X2n} \\ F_{X3n} \\ F_{X4n} \end{pmatrix} & F_{Y_1.5} &:= \begin{pmatrix} F_{Y1n} \\ F_{Y2n} \\ F_{Y3n} \\ F_{Y4n} \end{pmatrix} & F_{Zmax_1.5} &:= \begin{pmatrix} F_{Zmax1n} \\ F_{Zmax2n} \\ F_{Zmax3n} \\ F_{Zmax4n} \end{pmatrix} & F_{Zmin_1.5} &:= \begin{pmatrix} F_{Zmin1n} \\ F_{Zmin2n} \\ F_{Zmin3n} \\ F_{Zmin4n} \end{pmatrix} \\
 F_{X_1.2} &:= \begin{pmatrix} F_{X5n} \\ F_{X6n} \\ F_{X7n} \\ F_{X8n} \\ F_{X91n} \\ F_{X92n} \\ F_{X101n} \\ F_{X102n} \end{pmatrix} & F_{Y_1.2} &:= \begin{pmatrix} F_{Y5n} \\ F_{Y6n} \\ F_{Y7n} \\ F_{Y8n} \\ F_{Y91n} \\ F_{Y92n} \\ F_{Y101n} \\ F_{Y102n} \end{pmatrix} & F_{Zmax_1.2} &:= \begin{pmatrix} F_{Zmax5n} \\ F_{Zmax6n} \\ F_{Zmax7n} \\ F_{Zmax8n} \\ F_{Zmax91n} \\ F_{Zmax92n} \\ F_{Zmax101n} \\ F_{Zmax102n} \end{pmatrix} & F_{Zmin_1.2} &:= \begin{pmatrix} F_{Zmin5n} \\ F_{Zmin6n} \\ F_{Zmin7n} \\ F_{Zmin8n} \\ F_{Zmin91n} \\ F_{Zmin92n} \\ F_{Zmin101n} \\ F_{Zmin102n} \end{pmatrix} \\
 M_{X_1.5} &:= \begin{pmatrix} M_{X1n} \\ M_{X2n} \\ M_{X3n} \\ M_{X4n} \end{pmatrix} & M_{Y_1.5} &:= \begin{pmatrix} M_{Y1n} \\ M_{Y2n} \\ M_{Y3n} \\ M_{Y4n} \end{pmatrix}
 \end{aligned}$$

$$M_{X_1.2} := \begin{pmatrix} M_{X5n} \\ M_{X6n} \\ M_{X7n} \\ M_{X8n} \\ M_{X91n} \\ M_{X92n} \\ M_{X101n} \\ M_{X102n} \end{pmatrix} \quad M_{Y_1.2} := \begin{pmatrix} M_{Y5n} \\ M_{Y6n} \\ M_{Y7n} \\ M_{Y8n} \\ M_{Y91n} \\ M_{Y92n} \\ M_{Y101n} \\ M_{Y102n} \end{pmatrix}$$

Размери на фундамента. Foundation dimensions.

$b := 1.40\text{m}$	Ширина на основата на фундамента / Foundation width
$a := 1.40\text{m}$	Дължина на основата на фундамента / Foundation length
$d := 0.70\text{m}$	Ширина на подколонника / Foundation width over the base
$c := 0.70\text{m}$	Дължина на подколонника / Foundation length over the base
$h_{f0} := 0.15\text{m}$	Височина на подколонника над засипката / Foundation height above the embankment
$h_{f1} := 0.35\text{m}$	Височина на стъпката / Foudation base height
$h_{f2} := 1.20\text{m}$	Височина на подколонника / Height of the foundation over the base
$h_f := h_{f1} + h_{f2}$	$h_f = 1.55\text{m}$ Височина на фундамента / Foundation height

Определяне на вертикалната сила на долен ръб фундамент.

N_{F_nor}

Vertical stress on lower edge foundation

$\gamma := 24 \cdot \frac{\text{kN}}{\text{m}^3}$	Обемно тегло на бетона. Concrete unit weight.	
$\gamma_z := 16.5 \cdot \frac{\text{kN}}{\text{m}^3}$	Обемно тегло на засипка/ Converse embankment unit weight	
$G_1 := a \cdot b \cdot h_{f1} \cdot \gamma$	Тегло на фундаментната плоча/ Foundation base weight	$G_1 = 16.46 \text{ kN}$
$G_2 := c \cdot d \cdot h_{f2} \cdot \gamma$	Тегло на подколонникът/ Foundation weight over the base	$G_2 = 14.11 \text{ kN}$
$G_{fnor} := G_1 + G_2$	Собствено тегло на фундамента/ Foundation dead weight	$G_{fnor} = 30.58 \text{ kN}$
$G_{pnor} := (a \cdot b - c \cdot d) \cdot (h_{f2} - h_{f0}) \cdot \gamma_z$	Теглото на почвената засипка върху фундамента/ Soil embankment weight	$G_{pnor} = 25.47 \text{ kN}$

$$N_{F_nor_max_1.5} := F_{Zmax_1.5} + G_{fnor} + G_{pnor}$$

$$N_{F_nor_max_1.2} := F_{Zmax_1.2} + G_{fnor} + G_{pnor}$$

$$N_{F_nor_min_1.5} := F_{Zmin_1.5} + G_{fnor} + G_{pnor}$$

$$N_{F_nor_min_1.2} := F_{Zmin_1.2} + G_{fnor} + G_{pnor}$$

$$N_{F_nor_max_1.5} = \begin{pmatrix} 60.942 \\ 61.942 \\ 61.212 \\ 60.942 \end{pmatrix} \text{ kN}$$

$$N_{F_nor_min_1.5} = \begin{pmatrix} 59.483 \\ 59.483 \\ 59.213 \\ 59.483 \end{pmatrix} \text{ kN}$$

$$N_{F_nor_max_1.2} = \begin{pmatrix} 60.942 \\ 60.942 \\ 63.277 \\ 62.579 \\ 61.182 \\ 60.942 \\ 63.277 \\ 62.579 \end{pmatrix} \text{ kN}$$

$$N_{F_nor_min_1.2} = \begin{pmatrix} 59.483 \\ 59.483 \\ 59.934 \\ 60.633 \\ 59.243 \\ 59.483 \\ 59.934 \\ 60.633 \end{pmatrix} \text{ kN}$$

Определяне на запъващите моменти в основната плоскост на фундамента. M_{fun} **Restraining moments on the foundation base. M_{fun}**

Запъващ момент спрямо ос x в основната плоскост на фундамента./ Restraining moment direction X

$$M_{fun_X_1.5} := M_{X_1.5} + F_{Y_1.5} \cdot h_f \quad M_{fun_X_1.2} := M_{X_1.2} + F_{Y_1.2} \cdot h_f$$

Запъващ момент спрямо ос y в основната плоскост на фундамента./ Restraining moment direction Y

$$M_{fun_Y_1.5} := M_{Y_1.5} + F_{X_1.5} \cdot h_f \quad M_{fun_Y_1.2} := M_{Y_1.2} + F_{X_1.2} \cdot h_f$$

$$M_{fun_X_1.5} = \begin{pmatrix} 0.341 \\ 8.404 \\ 4.296 \\ 6.375 \end{pmatrix} \text{ kN} \cdot \text{m}$$

$$M_{fun_Y_1.5} = \begin{pmatrix} 0 \\ 3.9 \\ 2.16 \\ 0 \end{pmatrix} \text{ kN} \cdot \text{m}$$

$$M_{fun_X_1.2} = \begin{pmatrix} 0.341 \\ 4.296 \\ 4.41 \\ 11.64 \\ 0.341 \\ 2.19 \\ 0.455 \\ 7.685 \end{pmatrix} \text{ kN} \cdot \text{m}$$

$$M_{fun_Y_1.2} = \begin{pmatrix} 0 \\ 0 \\ 7.23 \\ 0 \\ 1.92 \\ 0 \\ 7.23 \\ 0 \end{pmatrix} \text{ kN} \cdot \text{m}$$

Определяне на напрежението на почвата под ъглите на фундамента/ soil stress under foundation corners. σ_{1_4}

$$F_{fund} := a \cdot b \quad \text{Основна площ на фундамента. Basic area of the Foundation.}$$

$$F_{fund} = 1.96 \text{ m}^2$$

$$W_x := \frac{a^2 \cdot b}{6} \quad W_x \text{ и } W_y \text{ са съпротивителните моменти на основната}$$

$$W_x = 0.46 \text{ m}^{3.00}$$

$$W_y := \frac{a \cdot b^2}{6} \quad W_x \text{ and } W_y \text{ are the resistance moments of the Foundation bed.}$$

$$W_y = 0.46 \text{ m}^{3.00}$$

$$\sigma_{1_max_1.5} := \frac{N_{F_nor_max_1.5}}{F_{fund}} - \frac{M_{fun_X_1.5}}{W_x} - \frac{M_{fun_Y_1.5}}{W_y} \quad \sigma_{1_max_1.2} := \frac{N_{F_nor_max_1.2}}{F_{fund}} - \frac{M_{fun_X_1.2}}{W_x} - \frac{M_{fun_Y_1.2}}{W_y}$$

$$\sigma_{1_min_1.5} := \frac{N_{F_nor_min_1.5}}{F_{fund}} - \frac{M_{fun_X_1.5}}{W_x} - \frac{M_{fun_Y_1.5}}{W_y} \quad \sigma_{1_min_1.2} := \frac{N_{F_nor_min_1.2}}{F_{fund}} - \frac{M_{fun_X_1.2}}{W_x} - \frac{M_{fun_Y_1.2}}{W_y}$$

$$\sigma_{2_max_1.5} := \frac{N_{F_nor_max_1.5}}{F_{fund}} - \frac{M_{fun_X_1.5}}{W_x} + \frac{M_{fun_Y_1.5}}{W_y} \quad \sigma_{2_max_1.2} := \frac{N_{F_nor_max_1.2}}{F_{fund}} - \frac{M_{fun_X_1.2}}{W_x} + \frac{M_{fun_Y_1.2}}{W_y}$$

$$\sigma_{2_min_1.5} := \frac{N_{F_nor_min_1.5}}{F_{fund}} - \frac{M_{fun_X_1.5}}{W_x} + \frac{M_{fun_Y_1.5}}{W_y} \quad \sigma_{2_min_1.2} := \frac{N_{F_nor_min_1.2}}{F_{fund}} - \frac{M_{fun_X_1.2}}{W_x} + \frac{M_{fun_Y_1.2}}{W_y}$$

$$\begin{aligned}\sigma_{3_max_1.5} &:= \frac{N_{F_nor_max_1.5}}{F_{fund}} + \frac{M_{fun_X_1.5}}{W_x} + \frac{M_{fun_Y_1.5}}{W_y} & \sigma_{3_max_1.2} &:= \frac{N_{F_nor_max_1.2}}{F_{fund}} + \frac{M_{fun_X_1.2}}{W_x} + \frac{M_{fun_Y_1.2}}{W_y} \\ \sigma_{3_min_1.5} &:= \frac{N_{F_nor_min_1.5}}{F_{fund}} + \frac{M_{fun_X_1.5}}{W_x} + \frac{M_{fun_Y_1.5}}{W_y} & \sigma_{3_min_1.2} &:= \frac{N_{F_nor_min_1.2}}{F_{fund}} + \frac{M_{fun_X_1.2}}{W_x} + \frac{M_{fun_Y_1.2}}{W_y} \\ \sigma_{4_max_1.5} &:= \frac{N_{F_nor_max_1.5}}{F_{fund}} + \frac{M_{fun_X_1.5}}{W_x} - \frac{M_{fun_Y_1.5}}{W_y} & \sigma_{4_max_1.2} &:= \frac{N_{F_nor_max_1.2}}{F_{fund}} + \frac{M_{fun_X_1.2}}{W_x} - \frac{M_{fun_Y_1.2}}{W_y} \\ \sigma_{4_min_1.5} &:= \frac{N_{F_nor_min_1.5}}{F_{fund}} + \frac{M_{fun_X_1.5}}{W_x} - \frac{M_{fun_Y_1.5}}{W_y} & \sigma_{4_min_1.2} &:= \frac{N_{F_nor_min_1.2}}{F_{fund}} + \frac{M_{fun_X_1.2}}{W_x} - \frac{M_{fun_Y_1.2}}{W_y}\end{aligned}$$

$$\begin{aligned}\sigma_{1_max_1.5} &= \begin{pmatrix} 30.347 \\ 4.7 \\ 17.114 \\ 17.153 \end{pmatrix} \frac{kN}{m^2} & \sigma_{2_max_1.5} &= \begin{pmatrix} 30.347 \\ 21.755 \\ 26.562 \\ 17.153 \end{pmatrix} \frac{kN}{m^2} & \sigma_{3_max_1.5} &= \begin{pmatrix} 31.839 \\ 58.506 \\ 45.347 \\ 45.032 \end{pmatrix} \frac{kN}{m^2} & \sigma_{4_max_1.5} &= \begin{pmatrix} 31.839 \\ 41.451 \\ 35.9 \\ 45.032 \end{pmatrix} \frac{kN}{m^2} \\ \sigma_{1_max_1.2} &= \begin{pmatrix} 30.347 \\ 21.7 \\ 6.833 \\ 6.477 \\ 26.27 \\ 26.305 \\ 15.48 \\ 15.123 \end{pmatrix} \frac{kN}{m^2} & \sigma_{2_max_1.2} &= \begin{pmatrix} 30.347 \\ 21.7 \\ 38.451 \\ 6.477 \\ 34.668 \\ 26.305 \\ 47.098 \\ 15.123 \end{pmatrix} \frac{kN}{m^2} & \sigma_{3_max_1.2} &= \begin{pmatrix} 31.839 \\ 40.486 \\ 57.735 \\ 57.379 \\ 36.16 \\ 35.881 \\ 49.089 \\ 48.732 \end{pmatrix} \frac{kN}{m^2} & \sigma_{4_max_1.2} &= \begin{pmatrix} 31.839 \\ 40.486 \\ 26.117 \\ 57.379 \\ 27.763 \\ 35.881 \\ 17.47 \\ 48.732 \end{pmatrix} \frac{kN}{m^2} \\ \sigma_{1_min_1.5} &= \begin{pmatrix} 29.602 \\ 3.445 \\ 16.094 \\ 16.409 \end{pmatrix} \frac{kN}{m^2} & \sigma_{2_min_1.5} &= \begin{pmatrix} 29.602 \\ 20.501 \\ 25.542 \\ 16.409 \end{pmatrix} \frac{kN}{m^2} & \sigma_{3_min_1.5} &= \begin{pmatrix} 31.095 \\ 57.252 \\ 44.327 \\ 44.288 \end{pmatrix} \frac{kN}{m^2} & \sigma_{4_min_1.5} &= \begin{pmatrix} 31.095 \\ 40.197 \\ 34.88 \\ 44.288 \end{pmatrix} \frac{kN}{m^2} \\ \sigma_{1_min_1.2} &= \begin{pmatrix} 29.602 \\ 20.956 \\ 5.128 \\ 5.484 \\ 25.281 \\ 25.561 \\ 13.774 \\ 14.13 \end{pmatrix} \frac{kN}{m^2} & \sigma_{2_min_1.2} &= \begin{pmatrix} 29.602 \\ 20.956 \\ 36.746 \\ 5.484 \\ 33.679 \\ 25.561 \\ 45.392 \\ 14.13 \end{pmatrix} \frac{kN}{m^2} & \sigma_{3_min_1.2} &= \begin{pmatrix} 31.095 \\ 39.741 \\ 56.03 \\ 56.386 \\ 35.171 \\ 35.136 \\ 47.383 \\ 47.74 \end{pmatrix} \frac{kN}{m^2} & \sigma_{4_min_1.2} &= \begin{pmatrix} 31.095 \\ 39.741 \\ 24.412 \\ 56.386 \\ 26.773 \\ 35.136 \\ 15.765 \\ 47.74 \end{pmatrix} \frac{kN}{m^2}\end{aligned}$$

Заклучение: Удовлетворени са условията на чл. 57(4) от Наредба №1 за проектиране на плоско фундиране..
Ъгловите и ръбовите напрежения не надвишават 150 kN/m².

Conclusion: The requirements of article 57(4) of Regulation No1 are fulfilled.
The stress on the edges and corners are below the limit of 150 kN/m².

Проверка за преобръщане на фундамента/ Foundation overturn check

Приемаме коефициент на сигурност 1,5 за основно съчетание и 1,2 за особено съчетание на натоварването съгласно чл. 75 от Наредба №1 за проектиране на плоско фундиране.

$k_{1.2} := 1.2$ Safety coefficient for exceptional loadcases $k_{1.5} := 1.5$ Safety coefficient for normal loadcases

$$M_{\text{zad_X_max_1.5}} := N_{\text{F_nor_max_1.5}} \cdot \frac{a}{2} \quad M_{\text{zad_X_max_1.2}} := N_{\text{F_nor_max_1.2}} \cdot \frac{a}{2}$$

Задържащ момент спрямо ос X в основната плоскост/ Restraining moment direction X

$$M_{\text{zad_X_min_1.5}} := N_{\text{F_nor_min_1.5}} \cdot \frac{a}{2} \quad M_{\text{zad_X_min_1.2}} := N_{\text{F_nor_min_1.2}} \cdot \frac{a}{2}$$

Задържащ момент спрямо ос Y в основната плоскост/ Restraining moment direction Y

$$M_{\text{zad_Y_max_1.5}} := N_{\text{F_nor_max_1.5}} \cdot \frac{b}{2} \quad M_{\text{zad_Y_max_1.2}} := N_{\text{F_nor_max_1.2}} \cdot \frac{b}{2}$$

$$M_{\text{zad_Y_min_1.5}} := N_{\text{F_nor_min_1.5}} \cdot \frac{b}{2} \quad M_{\text{zad_Y_min_1.2}} := N_{\text{F_nor_min_1.2}} \cdot \frac{b}{2}$$

Проверка за преобръщане по ос X.

$$M_{\text{check_X_1.5}} := M_{\text{fun_X_1.5}} \cdot k_{1.5} \quad M_{\text{check_X_1.2}} := M_{\text{fun_X_1.2}} \cdot k_{1.2}$$

Проверка за преобръщане по ос Y.

$$M_{\text{check_Y_1.5}} := M_{\text{fun_Y_1.5}} \cdot k_{1.5} \quad M_{\text{check_Y_1.2}} := M_{\text{fun_Y_1.2}} \cdot k_{1.2}$$

Условие за устойчивост на фундамента срещу преобръщане./ Conditions against overturn

$$\frac{M_{\text{zad_X_max_1.5}}}{M_{\text{fun_X_1.5}}} \geq k_{1.5} \quad \frac{M_{\text{zad_X_min_1.5}}}{M_{\text{fun_X_1.5}}} \geq k_{1.5} \quad \frac{M_{\text{zad_Y_max_1.5}}}{M_{\text{fun_Y_1.5}}} \geq k_{1.5} \quad \frac{M_{\text{zad_Y_min_1.5}}}{M_{\text{fun_Y_1.5}}} \geq k_{1.5}$$

$$\frac{M_{\text{zad_X_max_1.2}}}{M_{\text{fun_X_1.2}}} \geq k_{1.2} \quad \frac{M_{\text{zad_X_min_1.2}}}{M_{\text{fun_X_1.2}}} \geq k_{1.2} \quad \frac{M_{\text{zad_Y_max_1.2}}}{M_{\text{fun_Y_1.2}}} \geq k_{1.2} \quad \frac{M_{\text{zad_Y_min_1.2}}}{M_{\text{fun_Y_1.2}}} \geq k_{1.2}$$

$$\begin{aligned} M_{\text{check_X_1.5}} &= \begin{pmatrix} 0.512 \\ 12.606 \\ 6.443 \\ 9.563 \end{pmatrix} \text{ kN}\cdot\text{m} & M_{\text{zad_X_max_1.5}} &= \begin{pmatrix} 42.659 \\ 43.359 \\ 42.849 \\ 42.659 \end{pmatrix} \text{ kN}\cdot\text{m} & M_{\text{zad_X_min_1.5}} &= \begin{pmatrix} 41.638 \\ 41.638 \\ 41.449 \\ 41.638 \end{pmatrix} \text{ kN}\cdot\text{m} \\ \\ M_{\text{check_X_1.2}} &= \begin{pmatrix} 0.41 \\ 5.155 \\ 5.292 \\ 13.968 \\ 0.41 \\ 2.628 \\ 0.546 \\ 9.222 \end{pmatrix} \text{ kN}\cdot\text{m} & M_{\text{zad_X_max_1.2}} &= \begin{pmatrix} 42.659 \\ 42.659 \\ 44.294 \\ 43.805 \\ 42.827 \\ 42.659 \\ 44.294 \\ 43.805 \end{pmatrix} \text{ kN}\cdot\text{m} & M_{\text{zad_X_min_1.2}} &= \begin{pmatrix} 41.638 \\ 41.638 \\ 41.954 \\ 42.443 \\ 41.47 \\ 41.638 \\ 41.954 \\ 42.443 \end{pmatrix} \text{ kN}\cdot\text{m} \\ \\ M_{\text{check_Y_1.5}} &= \begin{pmatrix} 0 \\ 5.85 \\ 3.24 \\ 0 \end{pmatrix} \text{ kN}\cdot\text{m} & M_{\text{zad_Y_max_1.5}} &= \begin{pmatrix} 42.659 \\ 43.359 \\ 42.849 \\ 42.659 \end{pmatrix} \text{ kN}\cdot\text{m} & M_{\text{zad_Y_min_1.5}} &= \begin{pmatrix} 41.638 \\ 41.638 \\ 41.449 \\ 41.638 \end{pmatrix} \text{ kN}\cdot\text{m} \end{aligned}$$

$$M_{\text{check_Y_1.2}} = \begin{pmatrix} 0 \\ 0 \\ 8.676 \\ 0 \\ 2.304 \\ 0 \\ 8.676 \\ 0 \end{pmatrix} \text{ kN}\cdot\text{m} \quad M_{\text{zad_Y_max_1.2}} = \begin{pmatrix} 42.659 \\ 42.659 \\ 44.294 \\ 43.805 \\ 42.827 \\ 42.659 \\ 44.294 \\ 43.805 \end{pmatrix} \text{ kN}\cdot\text{m} \quad M_{\text{zad_Y_min_1.2}} = \begin{pmatrix} 41.638 \\ 41.638 \\ 41.954 \\ 42.443 \\ 41.47 \\ 41.638 \\ 41.954 \\ 42.443 \end{pmatrix} \text{ kN}\cdot\text{m}$$

$j := 0..3$
 $j1 := 0..7$

$$k_{X_max_1.5}(j) := \begin{cases} y \leftarrow M_{\text{fun_X_1.5}_j} \\ z \leftarrow \frac{M_{\text{zad_X_max_1.5}_j}}{y} & \text{if } y \neq 0 \\ z \leftarrow \infty & \text{otherwise} \end{cases} \quad k_{X_min_1.5}(j) := \begin{cases} y \leftarrow M_{\text{fun_X_1.5}_j} \\ z \leftarrow \frac{M_{\text{zad_X_min_1.5}_j}}{y} & \text{if } y \neq 0 \\ z \leftarrow \infty & \text{otherwise} \end{cases}$$

$$k_{X_max_1.2}(j1) := \begin{cases} y \leftarrow M_{\text{fun_X_1.2}_{j1}} \\ z \leftarrow \frac{M_{\text{zad_X_max_1.2}_{j1}}}{y} & \text{if } y \neq 0 \\ z \leftarrow \infty & \text{otherwise} \end{cases} \quad k_{Y_max_1.2}(j1) := \begin{cases} y \leftarrow M_{\text{fun_Y_1.2}_{j1}} \\ z \leftarrow \frac{M_{\text{zad_Y_max_1.2}_{j1}}}{y} & \text{if } y \neq 0 \\ z \leftarrow \infty & \text{otherwise} \end{cases}$$

$$k_{Y_max_1.5}(j) := \begin{cases} y \leftarrow M_{\text{fun_Y_1.5}_j} \\ z \leftarrow \frac{M_{\text{zad_Y_max_1.5}_j}}{y} & \text{if } y \neq 0 \\ z \leftarrow \infty & \text{otherwise} \end{cases} \quad k_{Y_min_1.5}(j) := \begin{cases} y \leftarrow M_{\text{fun_Y_1.5}_j} \\ z \leftarrow \frac{M_{\text{zad_Y_min_1.5}_j}}{y} & \text{if } y \neq 0 \\ z \leftarrow \infty & \text{otherwise} \end{cases}$$

$$k_{X_min_1.2}(j) := \begin{cases} y \leftarrow M_{\text{fun_X_1.2}_j} \\ z \leftarrow \frac{M_{\text{zad_X_min_1.2}_j}}{y} & \text{if } y \neq 0 \\ z \leftarrow \infty & \text{otherwise} \end{cases} \quad k_{Y_min_1.2}(j) := \begin{cases} y \leftarrow M_{\text{fun_Y_1.2}_j} \\ z \leftarrow \frac{M_{\text{zad_Y_min_1.2}_j}}{y} & \text{if } y \neq 0 \\ z \leftarrow \infty & \text{otherwise} \end{cases}$$

$k_{X_max_1.5}(j) =$	$k_{X_min_1.5}(j) =$	$k_{Y_max_1.5}(j) =$	$k_{Y_min_1.5}(j) =$
125.009	122.017	1·10 ³⁰⁷	1·10 ³⁰⁷
5.16	4.955	11.118	10.677
9.975	9.649	19.835	19.187
6.692	6.531	1·10 ³⁰⁷	1·10 ³⁰⁷

$k_{X_max_1.2}(j1) =$	$k_{X_min_1.2}(j1) =$	$k_{Y_max_1.2}(j1) =$	$k_{Y_min_1.2}(j1) =$
125.009	122.017	$1 \cdot 10^{307}$	$1 \cdot 10^{307}$
9.931	9.693	$1 \cdot 10^{307}$	$1 \cdot 10^{307}$
10.045	9.514	6.126	5.803
3.763	3.646	$1 \cdot 10^{307}$	$1 \cdot 10^{307}$
125.502	121.524	22.303	21.596
19.482	19.016	$1 \cdot 10^{307}$	$1 \cdot 10^{307}$
97.291	92.152	6.126	5.803
5.7	5.523	$1 \cdot 10^{307}$	$1 \cdot 10^{307}$

Заклучение: Минималният коефициент на преобръщане при основни комбинации е по-голям от 1.5.
Минималният коефициент на преобръщане при особени комбинации е по-голям 1.2.
Следователно фундамента е устойчив в експлоатационно отношение.

Conclusion: The min. overturn coefficient of normal loadcases is bigger than 1.5.
The min. overturn coefficient of exceptional loadcases is bigger than 1.2.
Hence the foundation is stable.

Изчисляване на земната основа по I-во гранично състояние - по носеща способност.

Calculation of the soil base acc.to the 1st limit condition - carrying ability

$$k_s := 1.2$$

$$e_{a_1.5} := \frac{k_s \cdot M_{fun_X_1.5}}{k_s \cdot \max(N_{F_nor_max_1.5})}$$

$$e_{b_1.5} := \frac{k_s \cdot M_{fun_Y_1.5}}{k_s \cdot \max(N_{F_nor_max_1.5})}$$

$$e_{a_1.2} := \frac{k_s \cdot M_{fun_X_1.2}}{k_s \cdot \max(N_{F_nor_max_1.2})}$$

$$e_{b_1.2} := \frac{k_s \cdot M_{fun_Y_1.2}}{k_s \cdot \max(N_{F_nor_max_1.2})}$$

$$e_{a_1.5} = \begin{pmatrix} 5.509 \times 10^{-3} \\ 0.136 \\ 0.069 \\ 0.103 \end{pmatrix} m \quad e_{b_1.5} = \begin{pmatrix} 0 \\ 0.063 \\ 0.035 \\ 0 \end{pmatrix} m$$

$$\max(e_{a_1.2}) \leq \frac{a}{3} \quad \max(e_{b_1.2}) \leq \frac{b}{3}$$

$$e_{a_1.2} = \begin{pmatrix} 5.393 \times 10^{-3} \\ 0.068 \\ 0.07 \\ 0.184 \\ 5.393 \times 10^{-3} \\ 0.035 \\ 7.195 \times 10^{-3} \\ 0.121 \end{pmatrix} m \quad e_{b_1.2} = \begin{pmatrix} 0 \\ 0 \\ 0.114 \\ 0 \\ 0.03 \\ 0 \\ 0.114 \\ 0 \end{pmatrix} m$$

$$\max(e_{a_1.2}) = 0.18 m \quad \frac{a}{3} = 0.47 m$$

$$\max(e_{b_1.2}) = 0.11 m \quad \frac{b}{3} = 0.47 m$$

**ОПРЕДЕЛЯНЕ НА АРМИРОВКАТА НА ФУНДАМЕНТА
СЪГЛАСНО НОРМИ ЗА ПРОЕКТИРАНЕ НА БЕТОННИ И СТОМАНОБЕТОННИ КОНСТРУКЦИИ-1995г.
НЕЦЕНТРИЧНО НАТИСНАТИ КОЛОНИ С ПРАВОЪГЪЛНО СЕЧЕНИЕ И СИМЕТРИЧНА АРИМРОВКА ЗА
ПОДКОЛОННИКА.**

FOUNDATION REINFORCEMENT

$$N_f := \max(F_{Z_{\max_1.2}}) + G_2 \quad N_f = 21.35 \text{ kN}$$

$$\gamma_{b2} := 1.0$$

$$b_{\text{max}} := c$$

$$\xi_R := 0.537$$

$$h_0 := c - 5 \cdot \text{cm}$$

$$R_b := 17.00 \cdot \text{MPa}$$

за бетон клас B20. / concrete class B20

$$R_{bt} := 1.2 \cdot \text{MPa}$$

за бетон клас B20. / concrete class B20

$$x_1 := \frac{N_f}{\gamma_{b2} \cdot R_b \cdot b_c}$$

$$x_1 = 0.18 \text{ cm}$$

$$x_R := \xi_R \cdot h_0$$

$$x_R = 34.90 \text{ cm}$$

$$\omega := 0.5 \cdot (1 + \xi_R)$$

$$\omega = 0.77$$

$$R_{sc} := 375 \cdot \text{MPa}$$

$$M_I := \max(M_{X_1.2}) + \max(F_{Y_1.2}) \cdot h_{f2}$$

$$e_0 := \frac{M_I}{N_f}$$

$$e_0 = 50.47 \text{ cm}$$

$$l_0 := 2 \cdot h_{f2}$$

$$e_a := \text{if} \left(\frac{c}{30} \geq \frac{l_0}{600}, \frac{c}{30}, \frac{l_0}{600} \right)$$

$$e_a = 2.33 \text{ cm}$$

$$A_{s_p_min} := 0.05\% \cdot c \cdot d$$

$$A_{s_min} := A_{s_p_min}$$

$$A_{s_p_min} = 2.45 \text{ cm}^{2.00}$$

$$J_s := A_{s_min} \cdot \left(\frac{c}{2} - 5 \cdot \text{cm} \right)^2 + A_{s_p_min} \cdot \left(\frac{c}{2} - 5 \cdot \text{cm} \right)^2$$

$$J_s = 4410.00 \text{ cm}^{4.00}$$

$$\alpha := \frac{E_s}{E_b}$$

$$\alpha = 7.27$$

За бетон клас B20 и стомана A III/
concrete class B20 an steel A III

$$\delta_e := \frac{e_0}{c}$$

$$\delta_e = 0.72$$

$$M_{11} := M_{X_1.5_1} + F_{Y_1.5_1} \cdot h_{f2}$$

$$\text{за/ for } \frac{a}{b} = 1.00$$

избираме/
chosen

$$\beta := 0.70$$

коэффициент за изчисляване на слягането в зависимост от формата на фундамента. По Табл. 4.1 от НППФ-1996г. / subsiding coefficient acc. to Table 4.1. НППФ-1996

$$\varphi_1 := 1 + \beta \cdot \frac{M_{11}}{M_I}$$

$$J_i := \frac{c \cdot d^3}{12}$$

$$N_{cr} := \frac{6.4 \cdot E_b}{l_0^2} \cdot \left[\frac{J_i}{\varphi_1} \cdot \left(\frac{0.11}{0.1 + \delta_e} \right) + \alpha \cdot J_s \right]$$

$$N_{cr} = 64183.11 \text{ kN}$$

$$\eta := \frac{1}{1 - \frac{N_f}{N_{cr}}}$$

$$\eta = 1.00$$

$$e_n := e_0 + e_a$$

$$e_{max} := e_n \cdot \eta + \frac{c}{2} + 5 \cdot cm$$

$$e_{max} = 0.93 \text{ m}$$

$$A_s := \frac{N_f \cdot e_{max} - \gamma_{b2} \cdot R_b \cdot x_1 \cdot b_c \cdot (h_0 - 0.5 \cdot x_1)}{R_{sc} \cdot (h_0 - 5 \cdot cm)}$$

$$A_{s1} := \frac{N_f \cdot e_{max} - \gamma_{b2} \cdot R_b \cdot b_c \cdot h_0^2 \cdot \omega \cdot (1 - 0.5 \cdot \omega)}{R_{sc} \cdot (h_0 - 5 \cdot cm)}$$

$$x_1 = 0.18 \text{ cm}$$

$$x_R = 34.90 \text{ cm}$$

$$\text{Reinforcement} := \text{if}(x_1 \leq x_R, A_s, A_{s1})$$

Опънна (натискова) армировка на подколонника -
Stretching (stress) reinforcement

$$\text{Reinforcement} = 0.26 \text{ cm}^{2.00}$$

ОПРЕДЕЛЯНЕ НА НОСЕЩАТА АРМИРОВКА НА СРЯЗВАНЕ - СТРЕМЕНА ЗА ПОДКОЛОННИКА. CALCULATION OF THE CARRYING REINFORCEMENT OF THE FOUNDATION TOP

$$Q := \text{if}(\max(F_{X_{1.2}}) > \max(F_{Y_{1.2}}), \max(F_{X_{1.2}}), \max(F_{Y_{1.2}}))$$

$$Q = 2.48 \text{ kN}$$

1. Проверка за достатъчност на сечението $Q \leq Q_{b1}$

1. Checking the reinf. section

$$Q_{b1} := 0.3 \cdot R_b \cdot d \cdot h_0$$

$$Q_{b1} = 2.32 \times 10^3 \text{ kN}$$

2. Проверка за способността на сечението само да понесе Q/ Q restrain check

$$Q \leq Q_{b2}$$

$$Q_{b2} := 0.6 \cdot R_{bt} \cdot d \cdot h_0$$

$$Q_{b2} = 327.60 \text{ kN}$$

Заклучение: Сечението е в състояние само да понесе срязването. Армировката е конструктивна - стремена ф8 през 20 см.

Conclusion: The requirements are fulfilled. The reinforcement is constructive ф8 through 20cm

ПРОВЕРКА НА ПРОДЪНВАНЕ/ COLLAPSE CHECK

$$\alpha_m := 1.2 \quad \text{за обикновен бетон клас B20/ concrete class B20}$$

$$u_m := 2 \cdot c + 2 \cdot d + 4 \cdot h_{f1}$$

$$N_{f_chk} := \alpha_m \cdot R_{bt} \cdot u_m \cdot h_0$$

$$N_f = 21.35 \text{ kN}$$

$$N_{f_chk} = 3931.20 \text{ kN}$$

ОПРЕДЕЛЯНЕ НА НОСЕЩА АРМИРОВКА ЗА ФУНДАМЕНТНАТА ПЛОЧА/ FOUNDATION REINFORCEMENT

1. Горна армировка/ Upper reinforcement

$$q := (h_{f2} - h_{f0}) \gamma_z$$

$$q = 17.32 \text{ kN} \cdot \text{m}^{-2.00}$$

$$l_k := \frac{a - c}{2}$$

$$l_k = 0.35 \text{ m}$$

$$M_{ku} := \frac{q \cdot l_k^2 \cdot 1 \cdot m}{2}$$

$$M_{ku} = 1.06 \text{ kN} \cdot \text{m}$$

$$\alpha_u := \frac{M_{ku}}{R_b \cdot 100 \cdot cm \cdot (h_{f1} - 5 \cdot cm)^2}$$

$$\alpha_u = 0.00069$$

$$\eta_{ku} := 0.995$$

$$A_{su} := \frac{M_{ku}}{R_{sc} \cdot \eta_{ku} \cdot (h_{f1} - 5 \cdot \text{cm})}$$

$$A_{su} = 0.09 \text{ cm}^{2.00}$$

за 1 линеен метър/ per linear meter

2. Долна армировка/ Lower reinforcement

$$\sigma_{\max} := \max(\max(\sigma_{1_{\max_1.2}}, \max(\sigma_{2_{\max_1.2}}), \max(\sigma_{3_{\max_1.2}}), \max(\sigma_{4_{\max_1.2}}))$$

$$\sigma_{\max} = 57.74 \frac{\text{kN}}{\text{m}^{2.00}}$$

$$M_{kb} := \frac{\sigma_{\max} \cdot l_k^2 \cdot 1 \cdot \text{m}}{2}$$

$$M_{kb} = 3.54 \text{ kN} \cdot \text{m}$$

$$\alpha_b := \frac{M_{kb}}{R_b \cdot 100 \cdot \text{cm} \cdot (h_{f1} - 5 \cdot \text{cm})^2}$$

$$\alpha_b = 0.002$$

$$\eta_{kb} := 0.9925$$

$$A_{sb} := \frac{M_{kb}}{R_{sc} \cdot \eta_{kb} \cdot (h_{f1} - 5 \cdot \text{cm})}$$

$$A_{sb} = 0.32 \text{ cm}^{2.00}$$

за 1 линеен метър/ per linear meter