Dejan Zupan

IZPITNE NALOGE IN REŠITVE NALOG S POSTOPKOM IZ PREDMETA STATIKA NA VISOKOŠOLSKEM ŠTUDIJU GRADBENIŠTVA

Igor Planinc

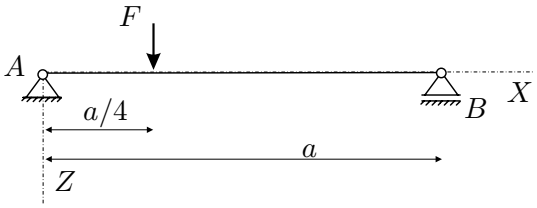
VPRAŠANJA IZ TEORIJE PRI PREDMETU STATIKA NA VISOKOŠOLSKEM ŠTUDIJU GRADBENIŠTVA

ŠTUDIJSKO LETO: 2004/05

STATIKA (VSŠ) - IZPITNI ROK (31. 01. 2005)

RAČUNSKI DEL IZPITA:

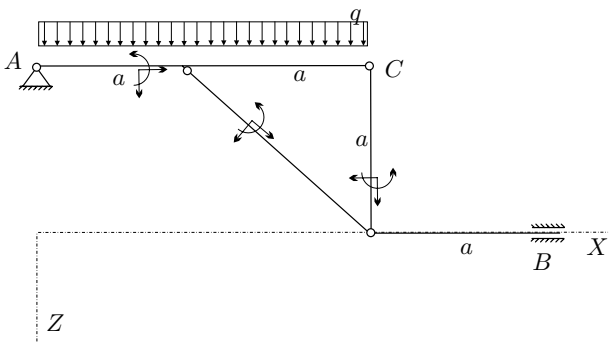
1. Za nosilec na sliki izračunajte in prikažite diagrame notranjih statičnih količin! ((OBVEZNA NALOGA! 15%)



. . . . . .

2. Za konstrukcijo na sliki izračunajte stopnjo statične nedoločenosti, reakcije in notranje statične količine (N_x, N_z, M_y)! Rezultate notranjih statičnih količin prikažite z diagrami!

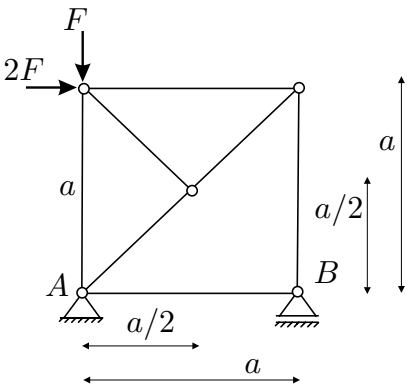
Podatki: $a = 2\,\mathrm{m}$,
$q = 5\,\mathrm{kN/m}$.
(OBVEZNA NALOGA! 50%)



. . . . . .

3. Za palično konstrukcijo na sliki izračunajte stopnjo statične nedoločenosti in osne sile v vseh palicah! (35%)

Podatki: $a = 4\,\mathrm{m}$, $F = 10\,\mathrm{kN}$.



TEORETIČNI DEL IZPITA:

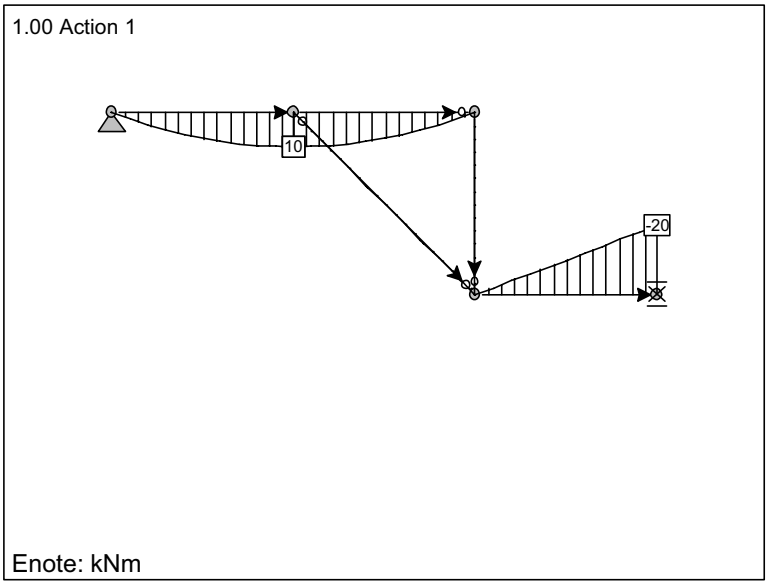
Izmed treh zastavljenih vprašanj si izberete dve, na kateri boste odgovarjali. Izbrani vprašanji jasno označite! Pišite čitljivo.

1. Vzporedna prestavitev sile! Kako lahko nadomestimo silo in moment, ki sta med seboj pravokotna? Dokaz!

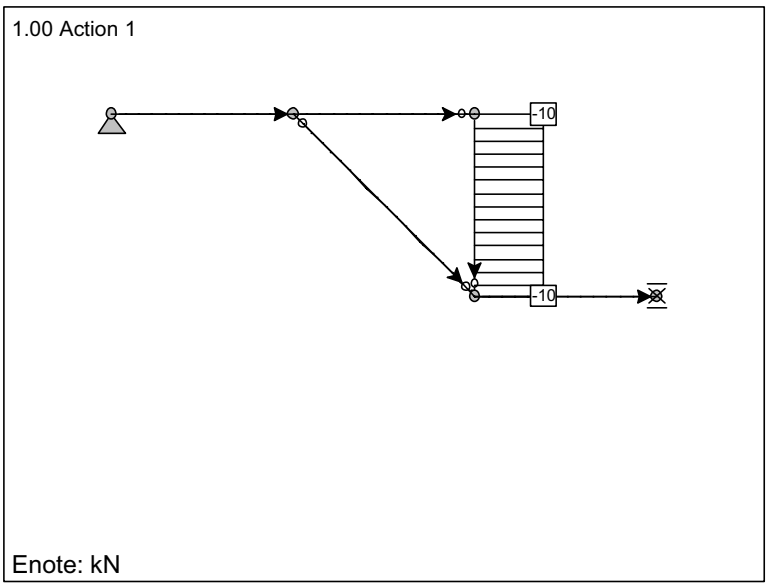
2. Izpeljite in opišite nadomestne ravnotežne pogoje!

3. Opišite določanje reakcij in notranjih sil statično določenih linijskih konstrukcij z izrekom o virtualnih pomikih (pomagajte si s primerom

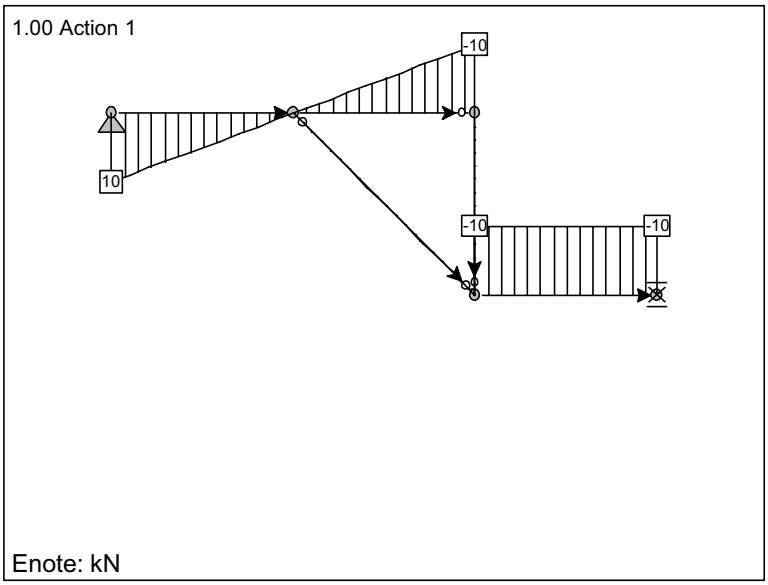
LC1: Load case 2: Upogibni moment My

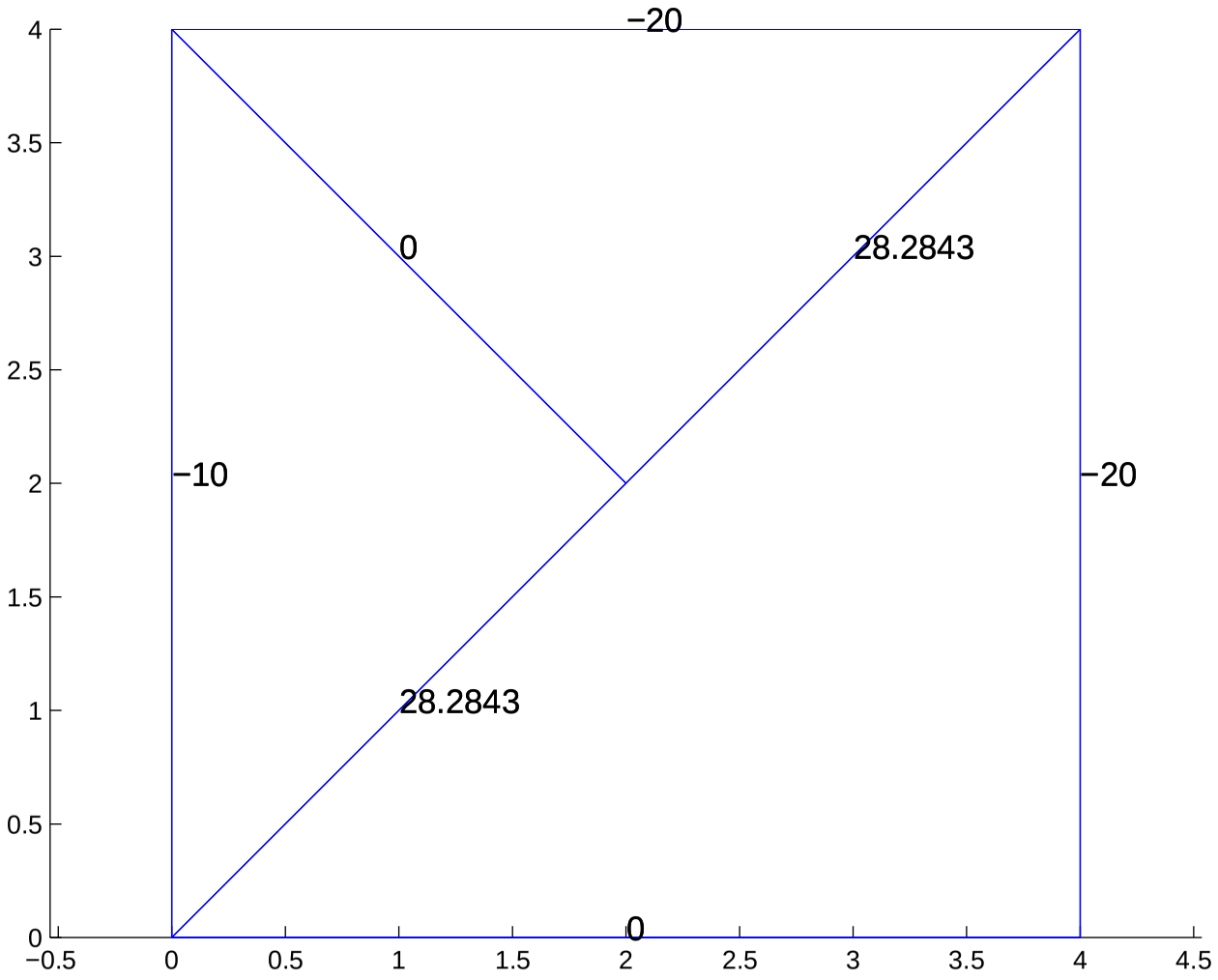


LC1: Load case 2: Osna sila Fx



LC1: Load case 2: Preèna sila Fz

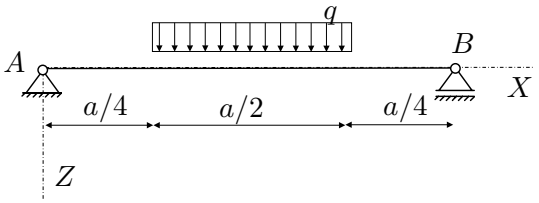



−20
0
28.2843
−10
−20
28.2843
0
4
3.5
3
2.5
2
1.5
1
0.5
0
−0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5

STATIKA (VSŠ) - 1. IZREDNI IZPITNI ROK (14. 3. 2005)

RAČUNSKI DEL IZPITA:

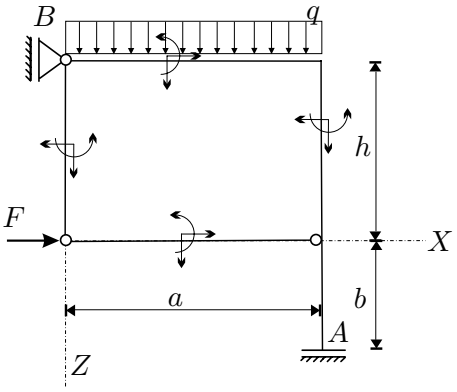
1. Za nosilec na sliki izračunajte reakcije v vezeh ter izračunajte in prikažite diagrame notranjih statičnih količin! (OBVEZNA NALOGA! 20%)



. . . . . .

2. Za konstrukcijo na sliki izračunajte stopnjo statične nedoločenosti, reakcije in notranje statične količine (N_x, N_z, M_y)! Rezultate notranjih statičnih količin prikažite z diagrami!

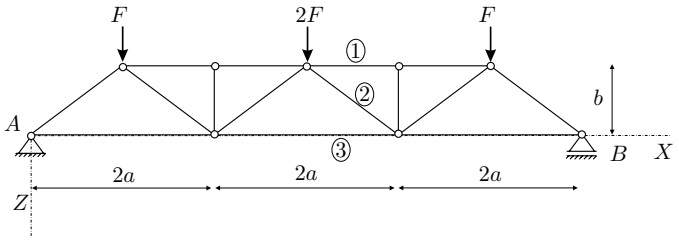
Podatki: $a = 4\,\mathrm{m}$, $h = 3\,\mathrm{m}$, $b = 2\,\mathrm{m}$, $q = 16\,\mathrm{kN/m}$, $F = 10\,\mathrm{kN}$.
(OBVEZNA NALOGA! 50%)



. . . . . .

3. Za palično konstrukcijo na sliki izračunajte stopnjo statične nedoločenosti in osne sile v palicah 1, 2 in 3! (30%)

Podatki: $a = 2\,\mathrm{m}$, $b = 1.5\,\mathrm{m}$, $F = 5\,\mathrm{kN}$.



TEORETIČNI DEL IZPITA:

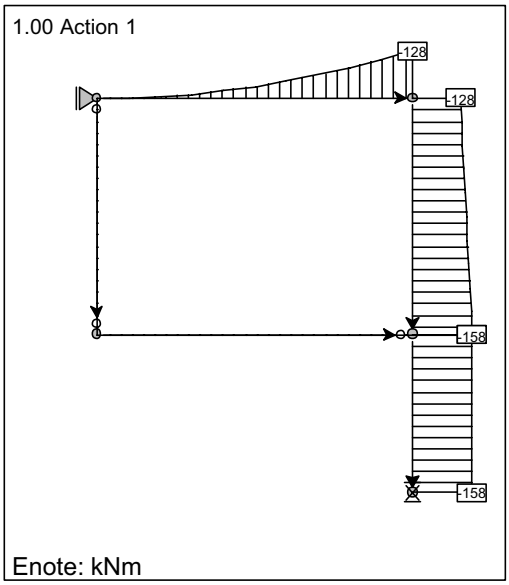
Izmed treh zastavljenih vprašanj si izberete dve, na kateri boste odgovarjali. Izbrani vprašanji jasno označite! Pišite čitljivo.

1. Izpeljite in opišite obe obliki nadomestnih ravnotežnih pogojev (rezultate ilustrirajte na prostoležečem nosilcu s točkovno silo na sredini razpona)!

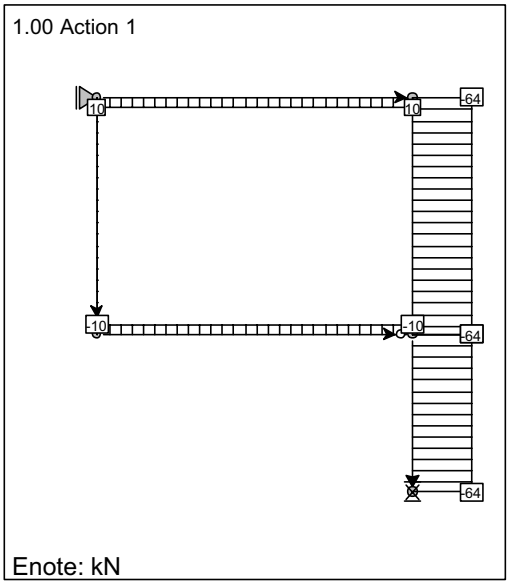
2. Izpeljite in opišite izraz za število odvzetih prostostnih stopenj, ki jih vez odvzame k nepovezanim telesom! Obravnavaj tudi primer, ko imajo vsa telesa na mestu vezi enake nekatere kinematične količine, preostale količine pa so možne za vsa telesa!

3. Opišite določanje reakcij in notranjih sil statično določenih linijskih konstrukcij z izrekom o virtualnih pomikih (ilustracija s primerom)!

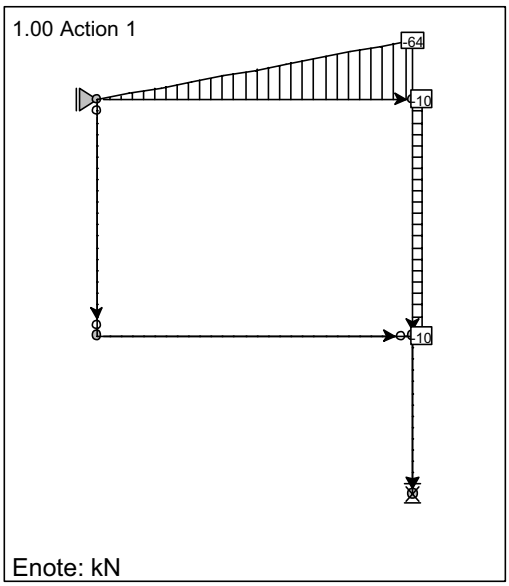
LC1: Load case 2: Upogibni moment My

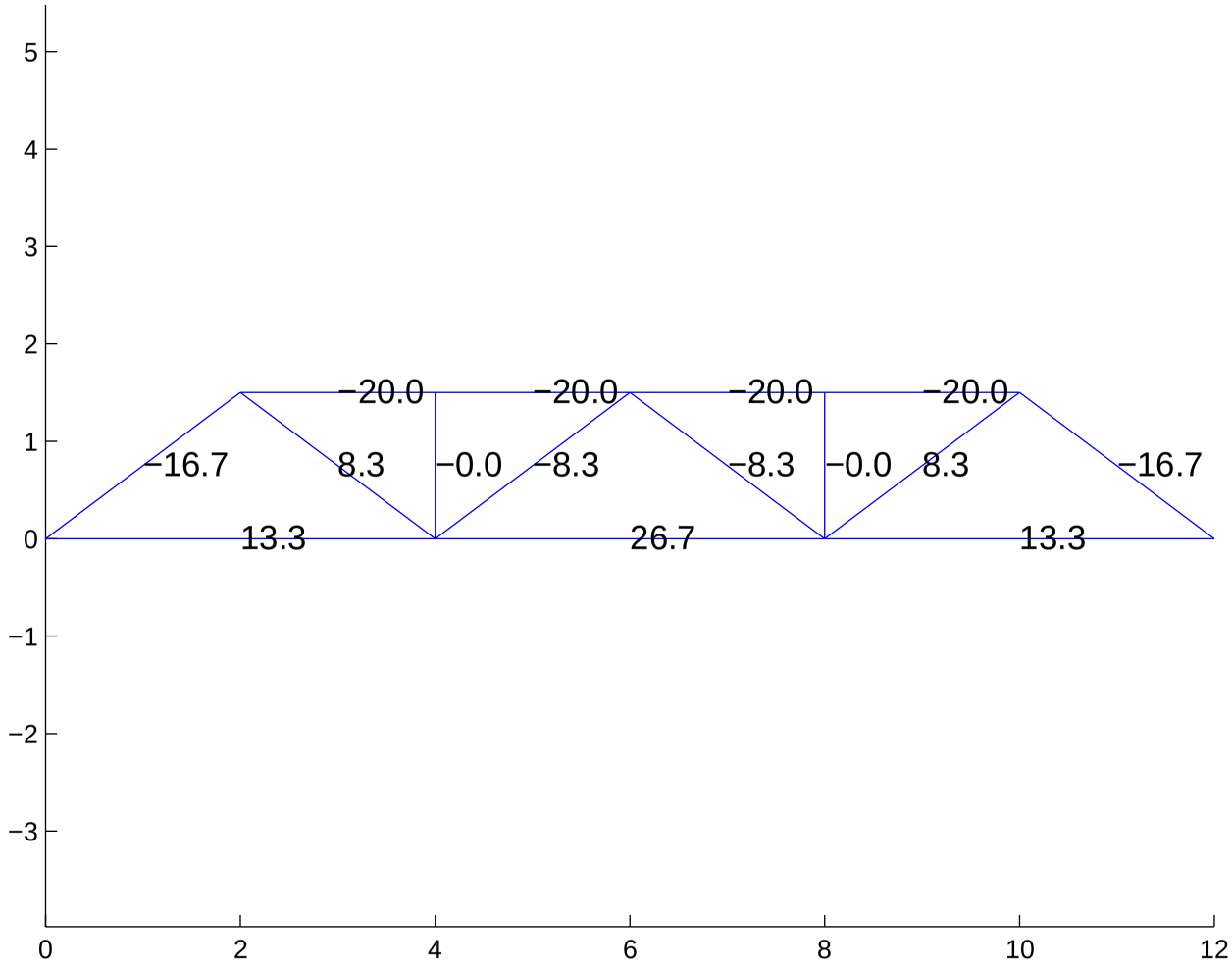


LC1: Load case 2: Osna sila Fx



LC1: Load case 2: Preèna sila Fz

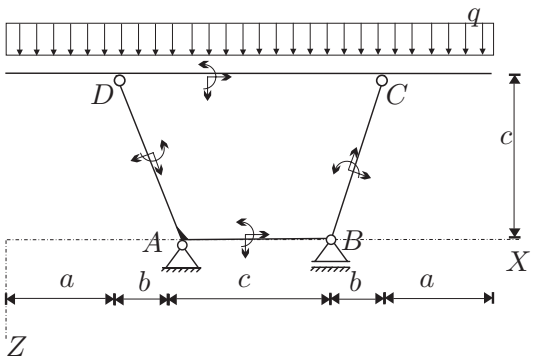



5
4
3
2
1
0
−1
−2
−3
0
2
4
6
8
10
12
−20.0
−20.0
−20.0
−20.0
−16.7
8.3
−0.0
−8.3
−8.3
−0.0
8.3
−16.7
13.3
26.7
13.3

STATIKA (VSŠ) - 1. IZPITNI ROK (10. 6. 2005)

RAČUNSKI DEL IZPITA:

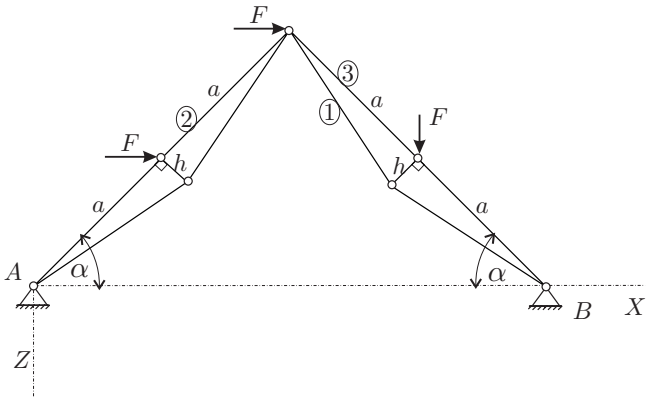
1. Za konstrukcijo na sliki izračunajte stopnjo statične nedoločenosti, reakcije in notranje statične količine (N_x, N_z, M_y)! Rezultate notranjih statičnih količin prikažite z diagrami!



Podatki: $a = 2\,\mathrm{m}$, $b = 1\,\mathrm{m}$, $c = 3\,\mathrm{m}$, $q = 5\,\mathrm{kN/m}$.
(OBVEZNA NALOGA! 40%)

.....

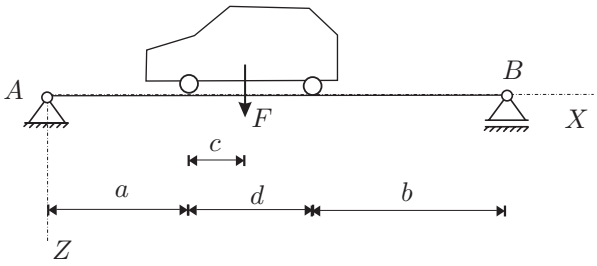
2. Za palično konstrukcijo na sliki izračunajte stopnjo statične nedoločenosti in osne sile v palicah 1, 2 in 3! (30%)



Podatki: $a = 4\,\mathrm{m}$, $h = 0.5\,\mathrm{m}$, $\alpha = 45°$, $F = 5\,\mathrm{kN}$.

.....

3. Izračunajte in narišite diagram upogibnih momentov v mostu na sliki! Most (prostoležeči nosilec) je obremenjen le s težo F vozila, ki ima prijemališče na razdalji c od prve osi. (30%)



Podatki: $a = 20\,\mathrm{m}$, $b = 7.5\,\mathrm{m}$, $c = 1\,\mathrm{m}$, $d = 2.5\,\mathrm{m}$, $F = 15\,\mathrm{kN}$.

TEORETIČNI DEL IZPITA:

Izmed treh zastavljenih vprašanj si izberete dve, na kateri boste odgovarjali. Izbrani vprašanji jasno označite! Pišite čitljivo.

1. Ravnotežni par sil in dvojica sil!

2. Račun reakcij in sil v vezeh pri statično določenih linijskih konstrukcijah (pomagajte si s primerom)!

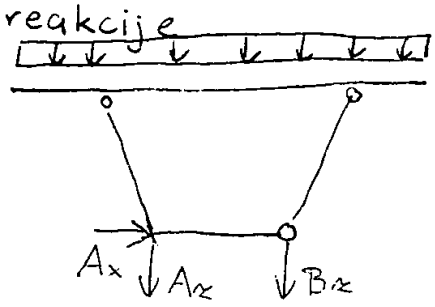
3. Definicija virtualnega pomika! Definicijo ilustrirajte s primerom!

STATIKA - VSŠ 10. 6. 2005

1. NALOGA

(i) $\tilde{n}_{PD} = 3 \cdot 3 - 1 - 2 - 3 \cdot 2 = 0$

(ii) reakcije



$\Sigma X: A_x = 0$

$\Sigma Z: A_z + B_z + g(2a+2b+c) = 0$

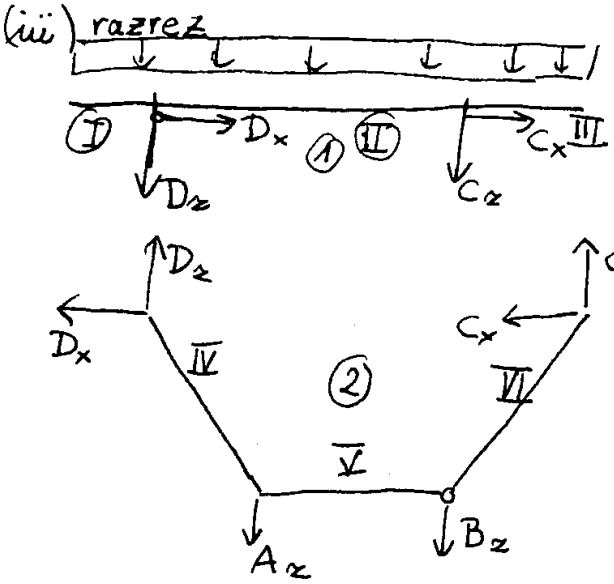
$\Sigma M^A: -B_z \cdot c - g\frac{(a+b+c)^2}{2} + g\frac{(a+b)^2}{2} = 0$

$B_z = \frac{1}{3}\left(\frac{5}{2}(3)^2 - \frac{5}{2}6^2\right)$

$= -\frac{5}{6}(36-9)$ $\quad \boxed{B_z = -22.5\ kN}$

$A_z = -5(4+2+3) + 22.5$ $\quad \boxed{A_z = -22.5\ kN}$

(iii) razrez



(2):

$\Sigma X: \quad C_x + D_x = 0$

$\Sigma Z: \quad C_z + D_z = A_z + B_z$

$\Sigma M^D: -A_z \cdot 3 - B_z \cdot 6 + C_z \cdot 9 = 0$

$C_z = \frac{1}{9}(A_z \cdot 3 + B_z \cdot 6)$

$\boxed{C_z = -22.5\ kN}$

$\boxed{D_z = -22.5\ kN}$

$\Sigma M^B_{BC}: C_x \cdot 3 + C_z 1 = 0$

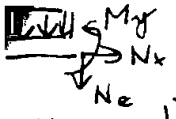
$C_x = -C_z \cdot \frac{1}{3}$

$\boxed{C_x = +7.5\ kN}$

$\boxed{D_x = -7.5\ kN}$

iv) notranje sile

polje I



$N_x = 0$ | $N_x = 0$

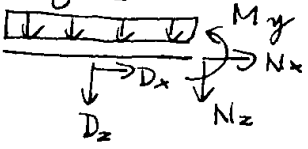
$N_z = -gx$ | $N_z = -5x$

$M_y = -g\frac{x^2}{2}$ | $M_y = -5\frac{x^2}{2}$

$N_z(2) = -10$

$M_y(2) = -10$

polje II



$N_x = -D_x$ | $N_x = 7{,}5$ kN

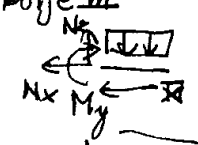
$N_z = -g(x+2) - D_z$ | $N_z = 12{,}5 - 5x$

$M_y = -g\frac{(x+2)^2}{2} - D_z \cdot x$ | $M_y = -10 + 12{,}5x - \frac{5}{2}x^2$

ekstrem $x = \frac{12{,}5}{5} = 2{,}5$ $\quad M_y(5) = 0$

$M_y(2{,}5) = 5{,}625$

polje III

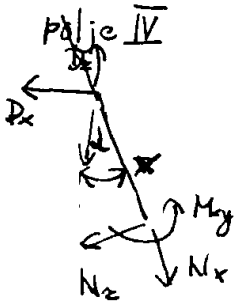


$N_x = 0$

$N_z = gx = 5x$

$M_y = -g\frac{x^2}{2} = -\frac{5}{2}x^2$

polje IV



$\Sigma x: +N_x - D_z \cdot \cos\alpha - D_x \sin\alpha = 0$

$\Sigma z: +N_z - D_z \cdot \sin\alpha + D_x \cos\alpha = 0$

$\Sigma M^T: -M_y - D_x \cdot x \cos\alpha + D_z \cdot x \sin\alpha = 0$

$\operatorname{tg}\alpha = \frac{1}{3}$

$\alpha = 18{,}435°$

$l = \sqrt{1+9} = \sqrt{10}$

$N_x = -7{,}5 \sin\alpha - 22{,}5 \cos\alpha$

$N_z = 7{,}5 \cos\alpha - 22{,}5 \sin\alpha$

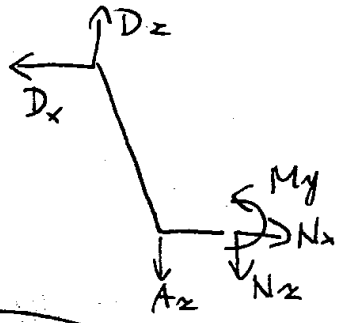
$M_y = N_z \cdot x$

$N_x = -23{,}7$ kN

$N_z = 0$

$M_y = 0$

polje V



$N_x = D_x = -7{,}5$

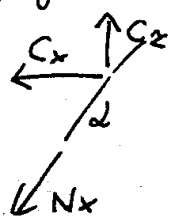
$N_z = D_z - A_z = 0$

$M_y + A_z \cdot x - D_z \cdot (x+1) + 3D_x = 0$

$M_y = 3 \cdot 7{,}5 - 22{,}5 = 0$

$M_y = 0$

polje VI



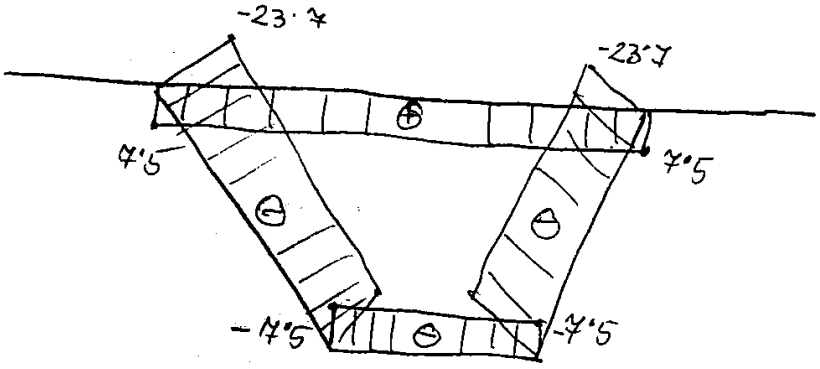
$N_x = C_z \cdot \cos\alpha - C_x \sin\alpha$

$= -22{,}5 \cos\alpha - 7{,}5 \sin\alpha$

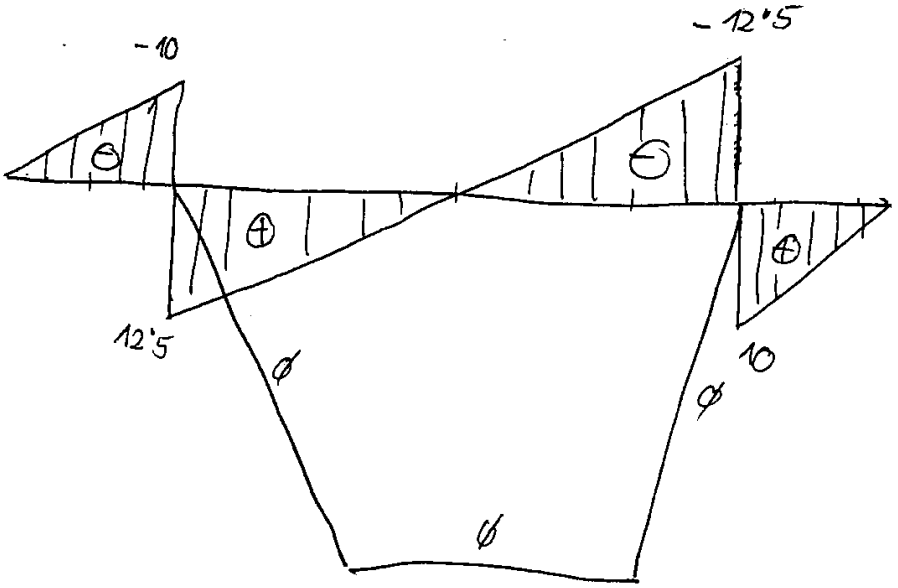
$N_x = -23{,}7$ kN

$N_z = M_y = 0$

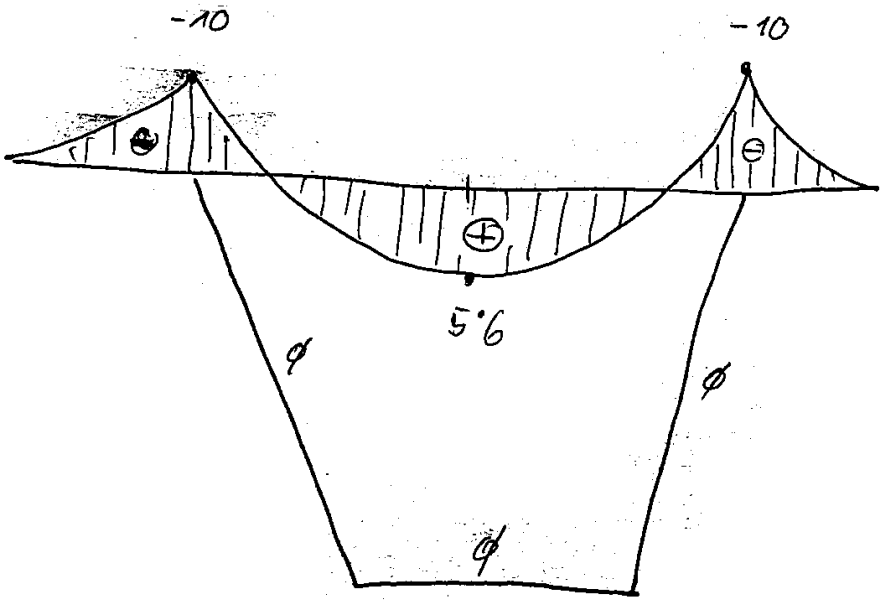
v) diagrami



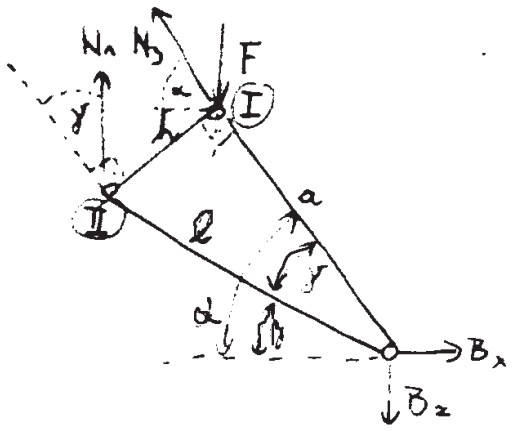
[N_z]



[M_y]



iv.) razrez 1-3 2. NAČIN



$$\Sigma M^{I}: -N_1 \cos\gamma \cdot l - B_z \cdot a \cos\alpha + B_x \cdot a \sin\alpha = 0$$

$$N_1 = \frac{a}{l\cos\gamma}\left(B_x \sin\alpha - B_z \cos\alpha\right)$$

$$N_1 = \frac{4}{0{,}5\cos\gamma}\left(-F\,\frac{\sqrt{2}}{2} + \frac{3}{2}F\,\frac{\sqrt{2}}{2}\right)$$

$$\boxed{N_1 = 14{,}25\ \text{kN}}$$

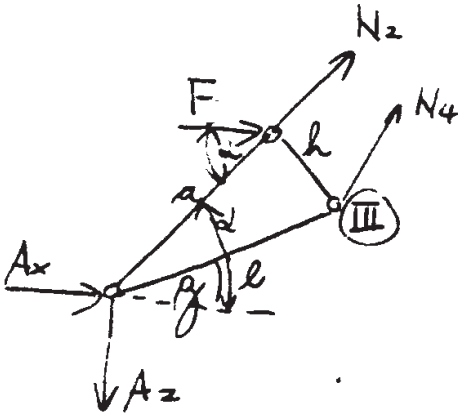
$$\Sigma M^{II}: N_3 \cdot l - F \cdot h \sin\alpha - B_x \cdot l \cos\beta + B_z \cdot l \sin\beta = 0$$

$$N_3 = \frac{1}{l}\left(F h \sin\alpha + B_x \cdot l \cos\beta - B_z l \sin\beta\right)$$

$$N_3 = \frac{1}{0{,}5}\left(5{,}05\,\frac{\sqrt{2}}{2} - \frac{3}{2}\cdot F \cdot l\cos\beta + F \cdot l \sin\beta\right)$$

$$\boxed{N_3 = -19{,}4\ \text{kN}}$$

v.) rez ②-④



$$\Sigma M^{III}: -N_2 \cdot l - F \cdot \cos\alpha \cdot h + A_z \cdot l \cos\beta + A_x \cdot l \sin\beta = 0$$

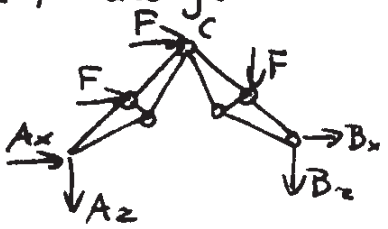
$$N_2 = \frac{1}{l}\left(-F h \cos\alpha + A_z \cdot l \cos\beta + A_x \cdot l \sin\beta\right) = 0$$

$$\boxed{N_2 = -12{,}4\ \text{kN}}$$

STATIKA - VSŠ 10.6.2005

(i) $\tilde{n}_{ps} = 10 - 2\cdot 5 = 0$

(ii) reakcije



ΣX: $A_x + B_x = -2F$

ΣZ: $A_z + B_z = -F$

ΣM^A: $-B_z \cdot 4a\frac{\sqrt{2}}{2} - F\cdot a\frac{\sqrt{2}}{2} - F2a\frac{\sqrt{2}}{2} - F3a\frac{\sqrt{2}}{2} = 0$

$4B_z = -6F$

$\boxed{B_z = -\frac{3}{2}F} = -7{,}5\ kN$

$\boxed{A_z = \frac{1}{2}F} = 2{,}5\ kN$

ΣM^C_{BC}: $-F\cdot a\frac{\sqrt{2}}{2} - B_z 2a\frac{\sqrt{2}}{2} + B_x \cdot 2a\frac{\sqrt{2}}{2} = 0$

$B_x = \frac{1}{2}(2B_z + F) = -\frac{3}{2}F + \frac{F}{2}$

$\boxed{B_x = -F} = -5\ kN$

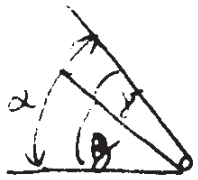
$\boxed{A_x = -F} = -5\ kN$

(iii) geometrija

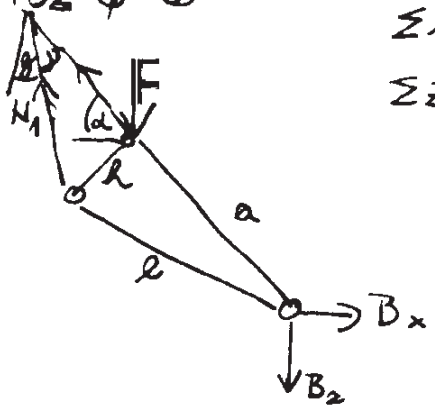
$l = \sqrt{a^2 + b^2} = \sqrt{16 + 0{,}25} = \underline{4{,}03}$

$\gamma = \operatorname{atan}\frac{b}{a} = \operatorname{atan}\frac{2{,}5}{4} = 7{,}1°$

$\beta = \frac{\pi}{4} - \gamma = \underline{37{,}875°}$



(iv) rez ①-③



Σx: $N_1 \sin\beta + N_3 \cos\alpha = B_x \quad / \cdot \cos\beta$

Σz: $N_1 \cos\beta + N_3 \sin\alpha = B_z + F \sin\beta \quad / \cdot (-)$

$N_3(\cos\alpha\cos\beta - \sin\alpha\sin\beta) = B_x\cos\beta - (B_z + F)\sin\beta$

$N_3 = \frac{-5\cos\beta + \frac{1}{2}5\sin\beta}{\frac{\sqrt{2}}{2}(\cos\beta - \sin\beta)}$

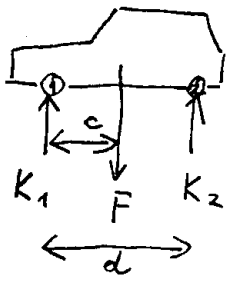
$\boxed{N_3 = -19{,}4\ kN}$

$N_1 = \frac{B_x - N_3\cdot\frac{\sqrt{2}}{2}}{\sin\beta}$

$\boxed{N_1 = 14{,}2\ kN}$

3. NALOGA

i.) vozilo



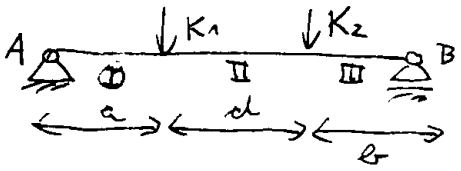
$\Sigma Z: \quad K_1 + K_2 = F$

$\Sigma M^{(1)} \quad -F \cdot c + K_2 \cdot d = 0$

$K_2 = F \cdot \frac{c}{d}$ $\qquad \boxed{K_2 = \frac{15}{2.5} = 6\ kN}$

$K_1 = F\left(1 - \frac{c}{d}\right)$ $\qquad \boxed{K_1 = 9\ kN}$

(ii) nosilec



$\Sigma X: \quad A_x = 0$

$\Sigma Z: \quad A_z + B_z + K_1 + K_2 = 0$

$\Sigma M^{A}: \quad -K_1 a - K_2(a+d) - B_z \cdot (a+b+d) = 0$

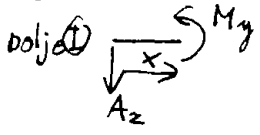
$B_z \cdot 30 = -9 \cdot 20 - 6 \cdot 22.5$

$\boxed{B_z = -10.5\ kN}$

$\boxed{A_z = -4.5\ kN}$

(iii) momenti

polje I

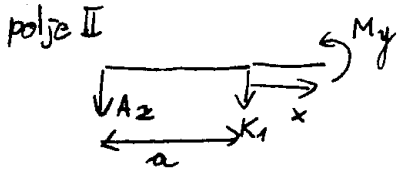


$M_y = -A_z x$

$\boxed{M_y = 4.5x}$

$M_y(20) = 90\ kN\,m$

polje II

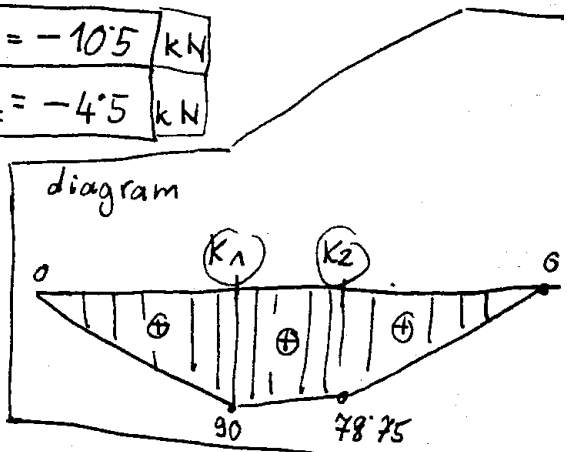


$M_y = -A_z x - A_z \cdot a - k_1 \cdot x$

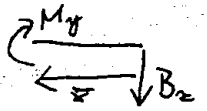
$\boxed{M_y = 90 - 4.5x}$

$M_y(25) = 78.75\ kN$

diagram



polje III



$M_y = -B_z \bar{x}$

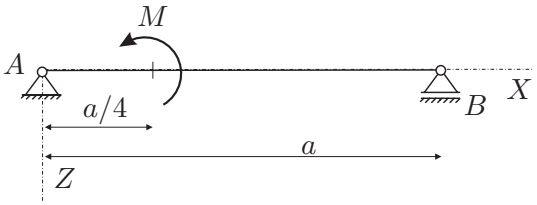
$\boxed{M_y = 10.5\bar{x}}$

$M_y(2.5) = 78.75\ kN$

STATIKA (VSŠ) - 2. IZPITNI ROK (27. 6. 2005)

RAČUNSKI DEL IZPITA:

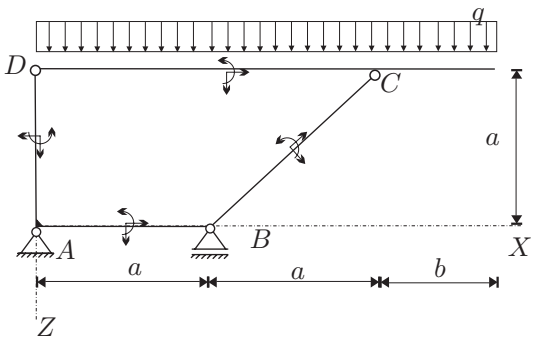
1. Za nosilec na sliki izračunajte reakcije v podporah ter izračunajte in prikažite diagrame notranjih statičnih količin! (OBVEZNA NALOGA! 20%)



. . . . . .

2. Za konstrukcijo na sliki izračunajte stopnjo statične nedoločenosti, reakcije in notranje statične količine (N_x, N_z, M_y)! Rezultate notranjih statičnih količin prikažite z diagrami!

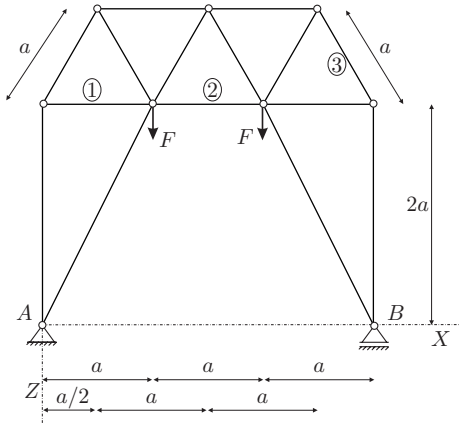
Podatki: $a = 3\,\mathrm{m}$, $b = 2\,\mathrm{m}$,
$q = 2\,\mathrm{kN/m}$.
(OBVEZNA NALOGA! 50%)



. . . . . .

3. Za palično konstrukcijo na sliki izračunajte stopnjo statične nedoločenosti in osne sile v palicah 1, 2 in 3! (30%)

Podatki: $a = 2\,\mathrm{m}$, $F = 10\,\mathrm{kN}$.



TEORETIČNI DEL IZPITA:

Izmed treh zastavljenih vprašanj si izberete dve, na kateri boste odgovarjali. Izbrani vprašanji jasno označite! Pišite čitljivo.

1. Rezultanta sil in rezultanta momentov. Dokaži, da smernica rezultante sil poteka skozi točko, na katero računamo rezultanto momentov! Kdaj sta dva sistema sil statično enakovredna?

2. Izpeljite ravnotežne pogoje za linijski element z ravno osjo!

3. Opišite določanje reakcij in notranjih sil statično določenih linijskih konstrukcij z izrekom o virtualnih pomikih (ilustracija s primerom)!

STATIKA - VSŠ 27. 6. 2005

1. NALOGA

a.) reakcije

$\Sigma X: \boxed{A_x = 0}$

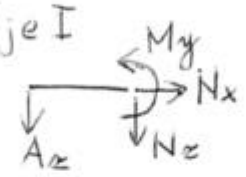
$\Sigma Z: A_z + B_z = 0$

$\Sigma M^A: M - B_z \cdot a = 0$

$$\boxed{B_z = \frac{M}{a}} \quad \boxed{A_z = -\frac{M}{a}}$$

b.) notranje sile

polje I

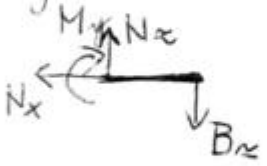


$\boxed{N_x = 0}$

$N_z = -A_z \quad \boxed{N_z = \frac{M}{a}}$

$M_y = -A_z x \quad \boxed{M_y = -\frac{M}{a} x} \quad M_y\left(\frac{a}{4}\right) = \frac{M}{4}$

polje II

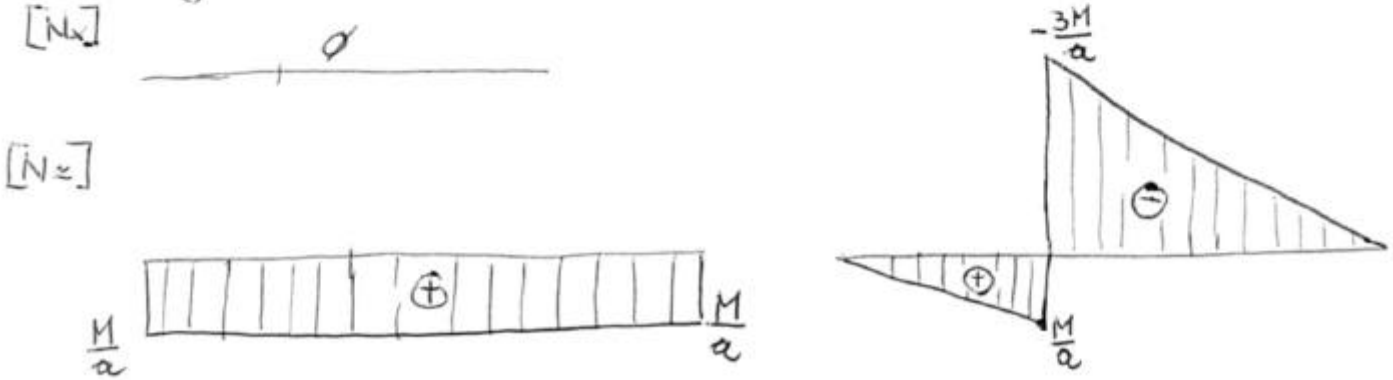


$\boxed{N_x = 0}$

$N_z = B_z \quad \boxed{N_z = \frac{M}{a}}$

$M_y = -B_z \bar{x} \quad \boxed{M_y = -\frac{M}{a} \bar{x}} \quad M_y\left(\frac{3a}{4}\right) = -\frac{3M}{4}$

c.) diagrami

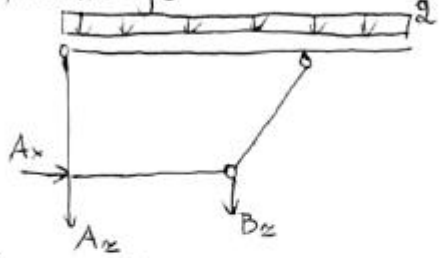


STATIKA - VSŠ 27. 6. 2005

2. NALOGA

a.) $\tilde{n}_{PS} = 3\cdot 3 - 2 - 1 - 3\cdot 2 = 0$ ✓

b.) reakcije



ΣX: $\boxed{A_x = 0}$

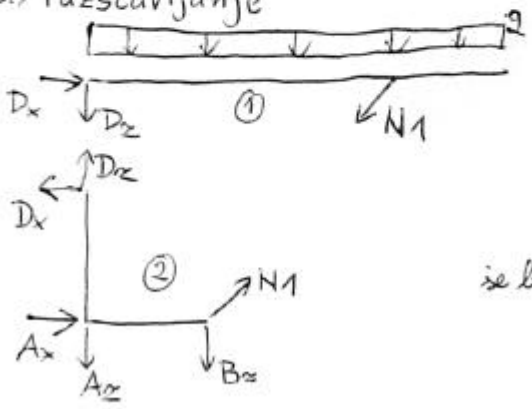
ΣZ: $A_z + B_z + q\cdot(2a+b) = 0$

ΣM^A: $-B_z\cdot a - q(2a+b)\frac{2a+b}{2} = 0$

$\boxed{B_z = -21{,}\overline{3}\ kN}$

$\boxed{A_z = +5{,}\overline{3}\ kN}$

c.) razstavljanje



②: ΣX: $A_x - D_x + N_1\frac{\sqrt{2}}{2} = 0$

ΣZ: $A_z + B_z - D_z - N_1\frac{\sqrt{2}}{2} = 0$

ΣM^A: $-B_z\cdot a + D_x a + N_1\frac{\sqrt{2}}{2}a = 0$ ← za kontrolo

ise bolje ΣM^D: $A_x\cdot\cancel{a} - B_z\cdot\cancel{a} + N_1\frac{\sqrt{2}}{2}\cancel{a} + N_1\frac{\sqrt{2}}{2}\cancel{a} = 0$

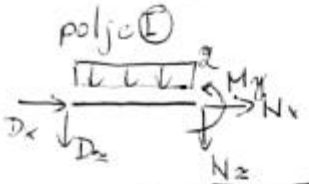
$N_1\sqrt{2} = B_z - A_x^{\,0}$

$\boxed{N_1 = -15{,}08\ kN}$

$\boxed{D_x = -10{,}\overline{6}\ kN}$ $\boxed{D_z = -5{,}\overline{3}\ kN}$

d.) notranje sile

polje ①



$N_x = -D_x \Rightarrow \boxed{N_x = 10{,}7\ kN}$

$N_z = -D_z - qx$

$\boxed{N_z = 5{,}\overline{3} - 2x}$ $N_z(6) = -6{,}\overline{7}\ kN$

$\boxed{M_y = 5{,}\overline{3}x - x^2}$ $M_y(6) = -4\ kNm$

$x = \frac{5{,}\overline{3}}{2}$ (ekstrem) $M_y\left(\frac{5{,}\overline{3}}{2}\right) = 7\ kNm$

polje ②

$\boxed{N_x = 0}$

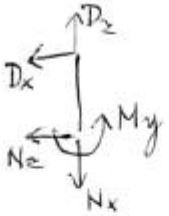
$N_z = qx$

$M_y = -qx\frac{x}{2}$

$\boxed{N_z = 2x}$ $N_z(2) = 4\ kN$

$\boxed{M_y = -x^2}$ $M_y(2) = -4\ kNm$

polje ③



$N_x = D_z$

$N_z = -D_x$

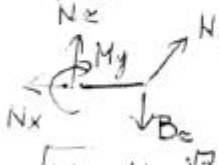
$M_y = -D_x x$

$\boxed{N_x = -5{,}\overline{3}\ kN}$

$\boxed{N_z = 10{,}\overline{6}\ kN}$

$\boxed{M_y = 10{,}7x}$ $M_y(3) = 32$

polje ④

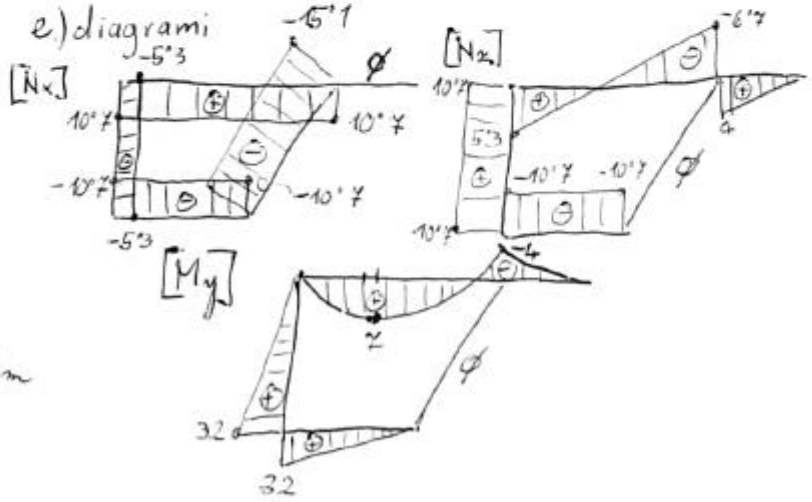


$\boxed{N_x = N_1\cdot\frac{\sqrt{2}}{2} = -10{,}7\ kN}$

$\boxed{N_z = B_z - N_1\frac{\sqrt{2}}{2} = -10{,}7\ kN}$

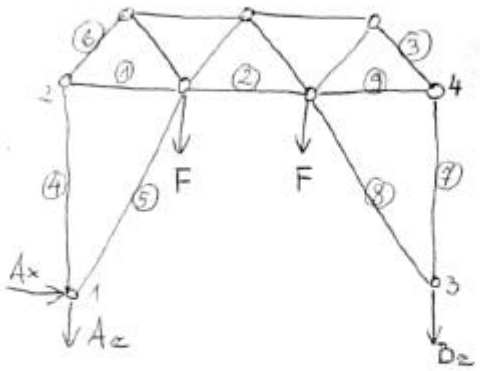
$\boxed{M_y = 10{,}7x}$ $M_y(3) = 32\ kNm$

e) diagrami



STATIKA – VSŠ 27. 6. 2005

3. NALOGA



reakcije

ΣX: $\boxed{A_x = 0}$

ΣZ: $A_z + B_z = -2F$

ΣM^A: $-F\cdot a - F\cdot 2a - B_z \cdot 3a = 0$

$A_z = -10\ kN \quad B_z = -10\ kN$

$\boxed{A_z = -F}$

$\boxed{B_z = -F}$

Izrezovanje vozlišč

[1]

$N_5 = 0$

$N_4 = -10kN$

[2]

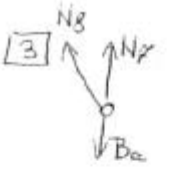
ΣX: $N_1 + N_6 \cos\alpha = 0$

ΣZ: $N_4 - N_6 \sin\alpha = 0$

$N_1 = -N_4 \operatorname{ctg}\alpha$

$\boxed{N_1 = 5'8\ kN}$

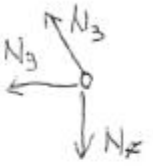
[3]



$N_7 = -10\ kN$

$N_8 = 0$

[4]

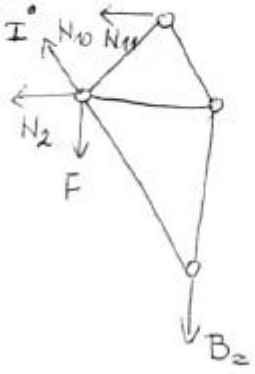


ΣZ: $-N_3 \sin\alpha + N_7 = 0$

$N_3 = \frac{N_7}{\sin\alpha}$

$\boxed{N_3 = -11'5\ kN}$

rez palice ②



ΣM^I: $-F\frac{a}{2} - B_z\frac{3a}{2} - N_2 a\frac{\sqrt{3}}{2} = 0$

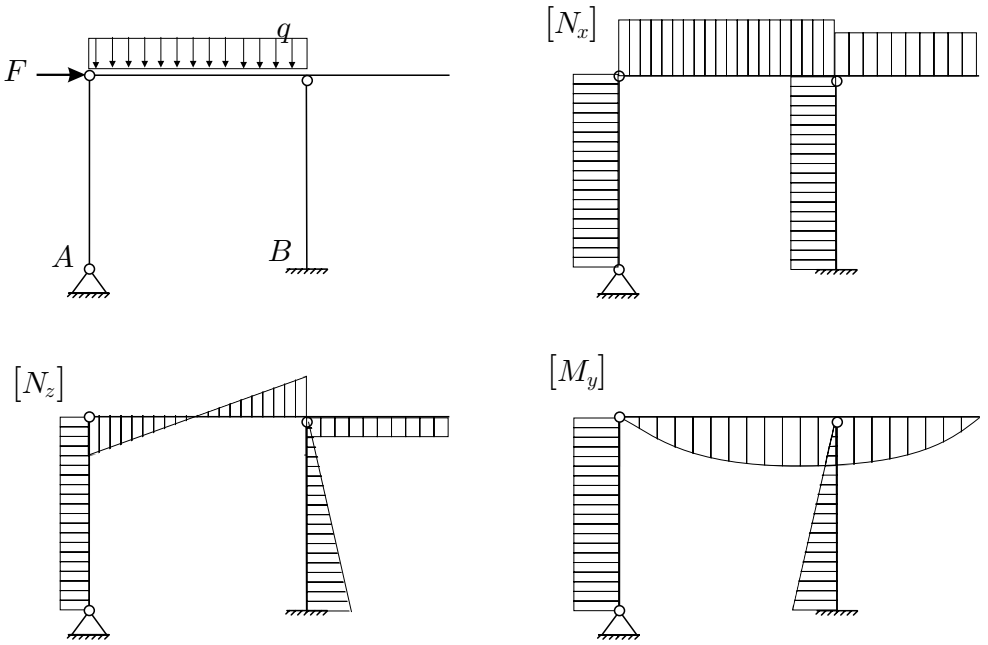
$N_2 = \frac{1}{\sqrt{3}}(-F - 3B_z)$

$\boxed{N_2 = 11'5\ kN}$

STATIKA (VSŠ) - 3. IZPITNI ROK (1. 9. 2005)

RAČUNSKI DEL IZPITA:

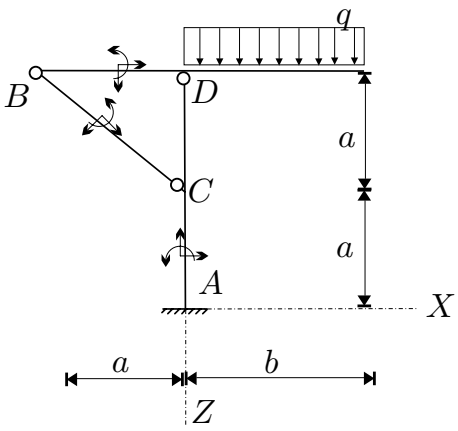
1. Janezek je na izpitu iz statike padel. Njegovi diagrami so polni napak. Pomagaj Janezku in poišči (BREZ RAČUNANJA) vse napake v spodnjih diagramih ! (OBVEZNA NALOGA! 25%)



. . . . . .

2. Za konstrukcijo na sliki izračunajte stopnjo statične nedoločenosti, reakcije in notranje statične količine (N_x, N_z, M_y)! Rezultate notranjih statičnih količin prikažite z diagrami!

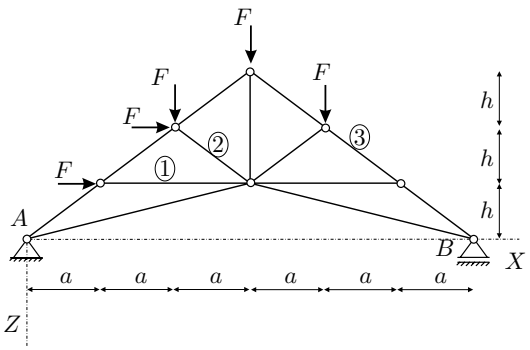
Podatki: $a = 2\,\mathrm{m}$, $b = 3\,\mathrm{m}$,
$q = 2\,\mathrm{kN/m}$.
(OBVEZNA NALOGA! 45%)



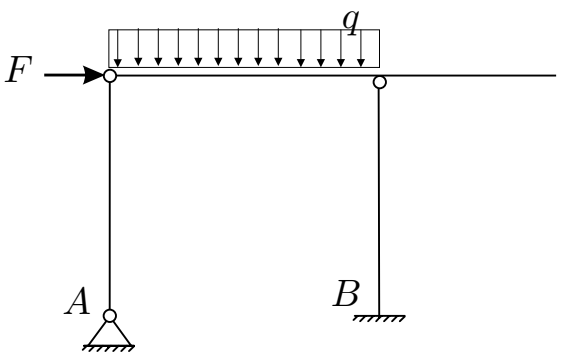
. . . . . .

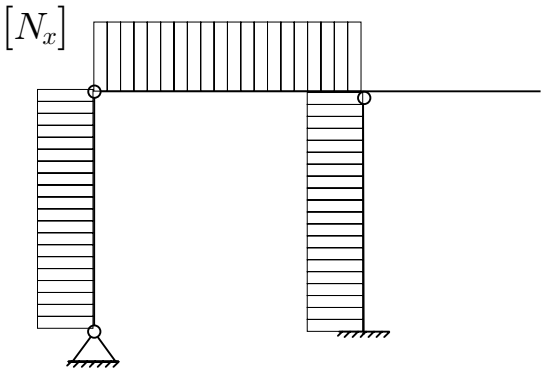
3. Za palično konstrukcijo na sliki izračunajte stopnjo statične nedoločenosti in osne sile v palicah 1, 2 in 3! (30%)

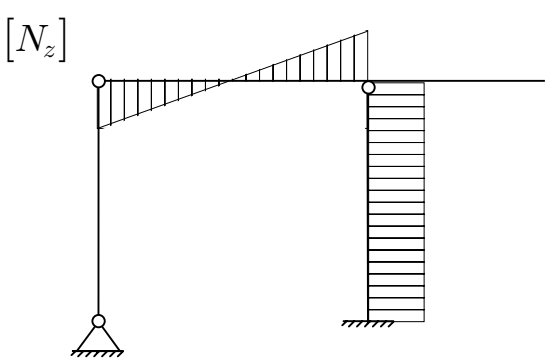
Podatki: $a = 2\,\mathrm{m}$, $h = 1.5\,\mathrm{m}$,
$F = 5\,\mathrm{kN}$.

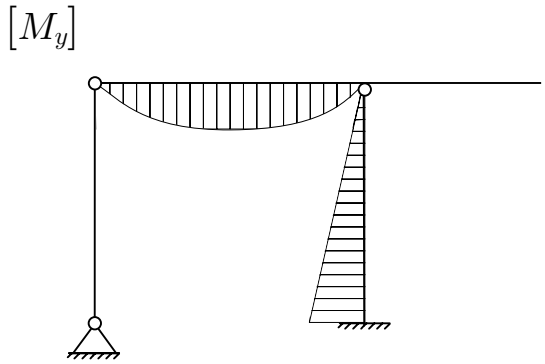


1. Naloga: PRAVILNI DIAGRAMI







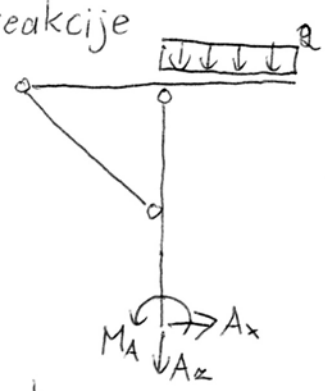


STATIKA - VSŠ 1. 9. 2005

2. NALOGA

a.) $\widetilde{m}_{PS} = 3 \cdot 3 - 3 - 3 \cdot 2 = 0$

b.) reakcije

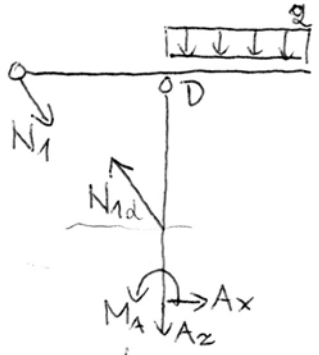


ΣX: $\boxed{A_x = 0}$

ΣZ: $A_z + q \cdot b = 0$ $\boxed{A_z = -6\,kN}$

ΣM^A: $M_A - q b \frac{b}{2} = 0$ $\boxed{M_A = 9\,kNm}$

c.) palica

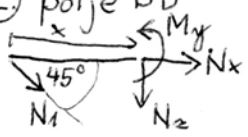


$\sum_{AD} M^D$: $M_A + A_x \cdot 2a - N_1 \cdot \frac{\sqrt{2}}{2} \cdot a = 0$

$N_1 = \frac{2}{\sqrt{2}} \frac{M_A}{a}$ $\boxed{N_1 = 6.4\,kN}$

d.) notranje sile

Ⅰ. polje BD



$N_x = -N_1 \frac{\sqrt{2}}{2}$

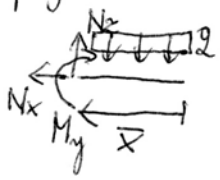
$N_z = -N_1 \frac{\sqrt{2}}{2}$

$M_y = -N_1 \frac{\sqrt{2}}{2} x$

$\boxed{N_x = -4{,}5\,kN}$ $\boxed{N_z = -4{,}5\,kN}$

$\boxed{M_y = -4{,}5\,x}$

Ⅱ. polje DE



$\boxed{N_x = 0}$

$N_z = q\bar{x}$

$M_y = -q\bar{x}\frac{\bar{x}}{2}$

$\boxed{N_z = 2\bar{x}}$ $\boxed{M_y = -\bar{x}^2}$

Ⅲ. polje AC

$N_x = A_z$

$N_z = -A_x$

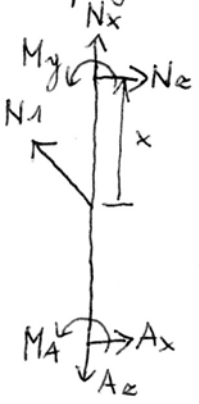
$M_y = -A_x x - M_A$

$\boxed{N_x = -6\,kN}$

$\boxed{N_z = 0}$

$\boxed{M_y = -9\,kNm}$

Ⅳ. polje CD



$N_x = A_z - N_1 \frac{\sqrt{2}}{2}$

$N_z = -A_x + N_1 \frac{\sqrt{2}}{2}$

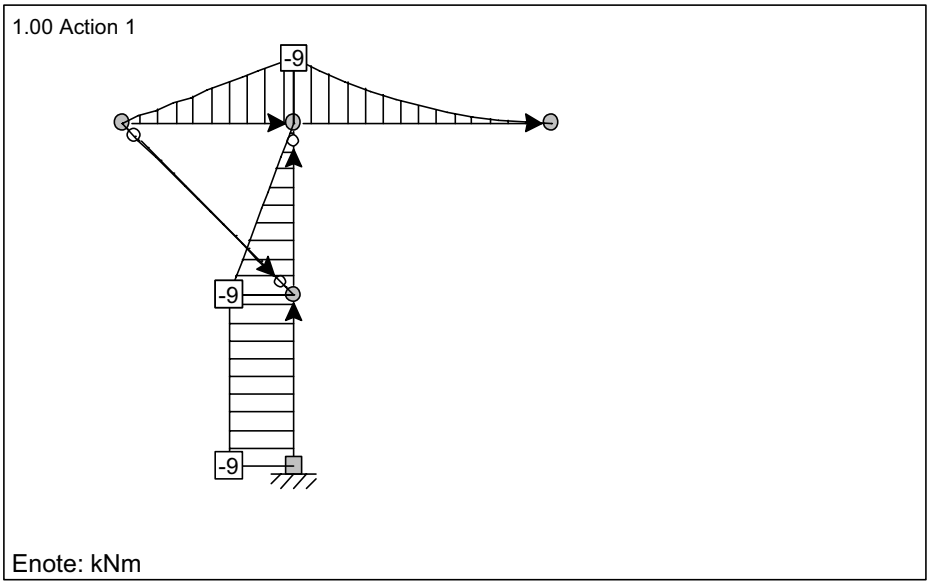
$M_y = -M_A + N_1 \frac{\sqrt{2}}{2} x - A_x(a+x)$

$\boxed{N_x = -10{,}5\,kN}$

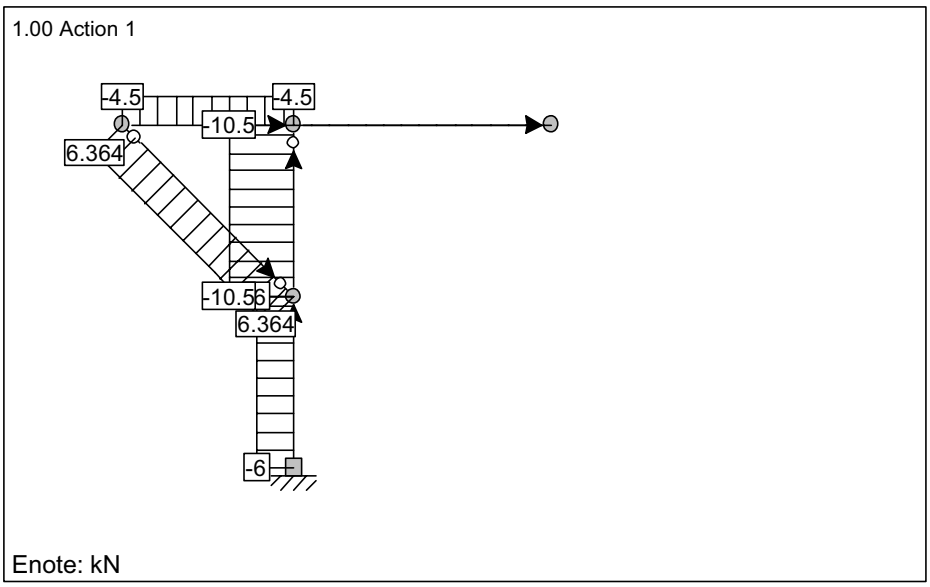
$\boxed{N_z = 4{,}5\,kN}$

$\boxed{M_y = -9 + 4{,}5x}$

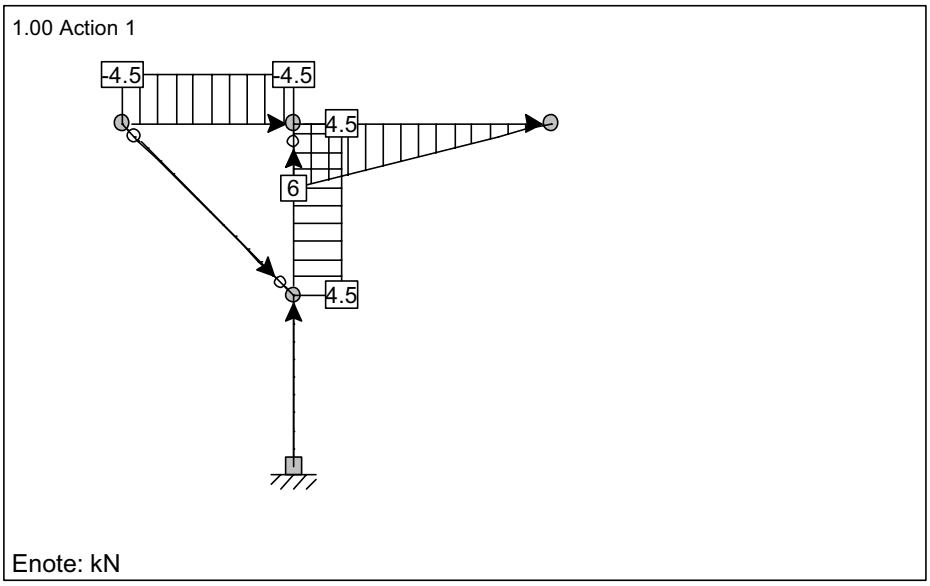
LC1: Load case 2: Upogibni moment My



LC1: Load case 2: Osna sila Fx



LC1: Load case 2: Preèna sila Fz

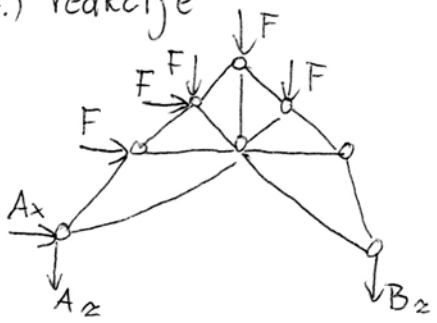


STATIKA - VSŠ 1. 9. 2005

3. NALOGA

a.) $\tilde{n}_{PS} = 13 - 6 \cdot 2 - 1 = 0$

b.) reakcije



$\Sigma X: \quad A_x + 2F = 0$

$\Sigma Z: \quad A_z + B_z + 3F = 0$

$\Sigma M^A: \quad -B_z \cdot 6a - F \cdot 2a - F \cdot 3a - F4a - Fh - F2h = 0$

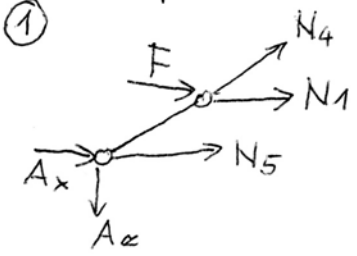
$B_z = -9{,}375 \text{ kN}$

$A_z = -5{,}625 \text{ kN}$

$A_x = -10 \text{ kN}$

c.) sile v palicah

①

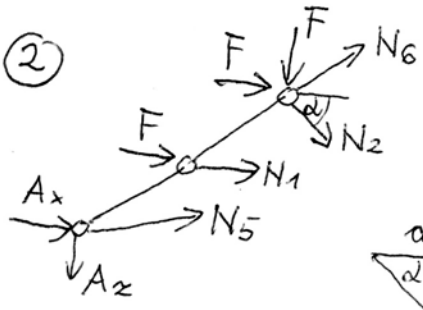


$\Sigma M^A: \quad -F \cdot h - N_1 \cdot h = 0$

$N_1 = -F$

$N_1 = -5 \text{ kN}$

②



$\Sigma M^A: \quad -F \cdot h - N_1 h - F \cdot 2h - F \cdot 2a$

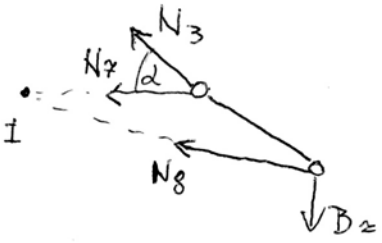
$-N_2 \cdot \cos\alpha \cdot 2h - N_2 \cdot \sin\alpha \cdot 2a = 0$

$\operatorname{tg}\alpha = \frac{h}{a}$

$\alpha = 36{,}87°$

$N_2 = -7{,}3 \text{ kN}$

③



$\Sigma M^I: \quad -B_z \cdot 3a + N_3 \cdot \sin\alpha \cdot 2a = 0$

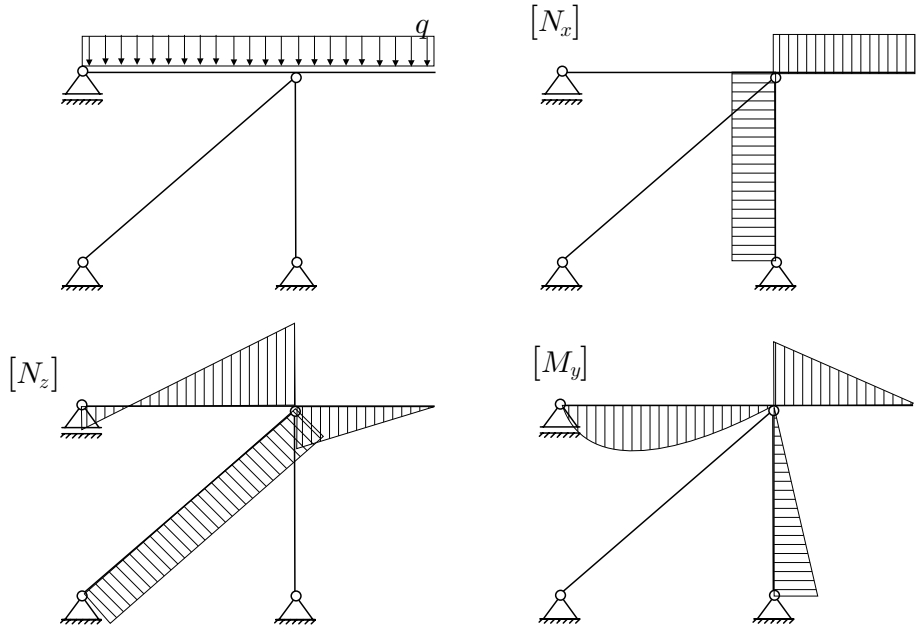
$N_3 = \frac{3}{2} \frac{B_z}{\sin\alpha}$

$N_3 = -23{,}4 \text{ kN}$

STATIKA (VSŠ) - 4. IZPITNI ROK (15. 9. 2005)

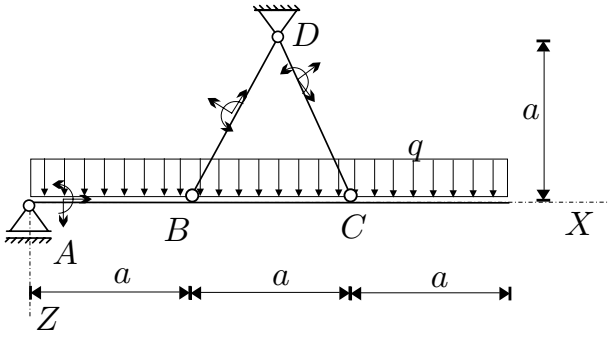
RAČUNSKI DEL IZPITA:

1. Janezek je na izpitu iz statike padel. Njegovi diagrami so polni napak. Pomagaj Janezku in poišči (BREZ RAČUNANJA) vse napake v spodnjih diagramih ! (OBVEZNA NALOGA! 25%)



. . . . . .

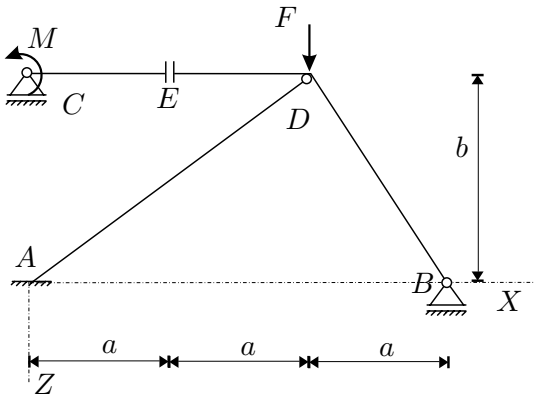
2. Za konstrukcijo na sliki izračunajte stopnjo statične nedoločenosti, reakcije in notranje statične količine (N_x, N_z, M_y)! Rezultate notranjih statičnih količin prikažite z diagrami! (OBVEZNA NALOGA! 45%)
Podatki: $a = 3\,\mathrm{m}$,
$q = 5\,\mathrm{kN/m}$.
(OBVEZNA NALOGA! 45%)



. . . . . .

3. Za konstrukcijo na sliki izračunajte reakcije in sile v vezeh! (30%)

Podatki: $a = 2\,\mathrm{m}$, $b = 3\,\mathrm{m}$,
$F = 10\,\mathrm{kN}$, $M = 2\,\mathrm{kNm}$.



TEORETIČNI DEL IZPITA:

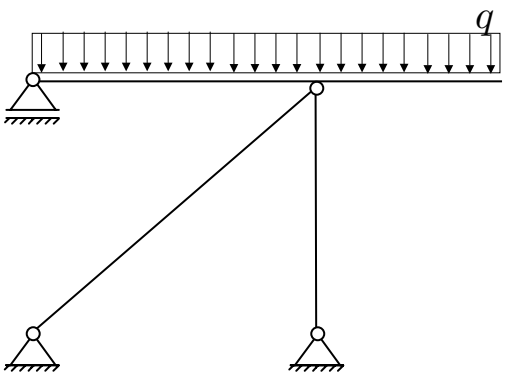
Izmed treh zastavljenih vprašanj si izberete dve, na kateri boste odgovarjali. Izbrani vprašanji jasno označite! Pišite čitljivo.

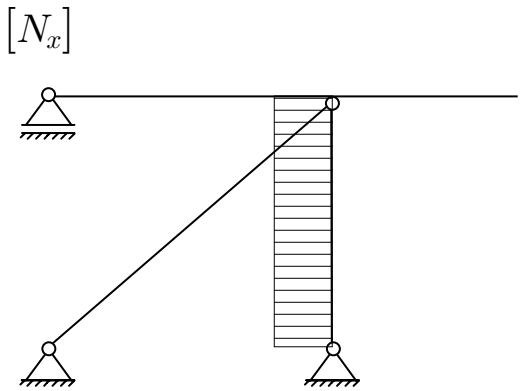
1. Ravnotežni par sil in dvojica sil!

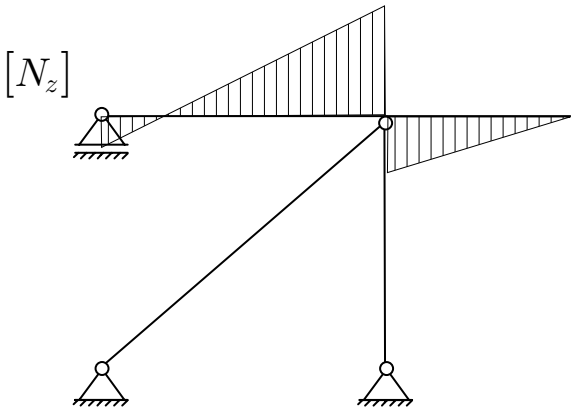
2. Kdaj govorimo o statično določenih oziroma statično nedoločenih linijskih konstrukcijah? Odgovor konkretizirajte z značilnimi primeri!

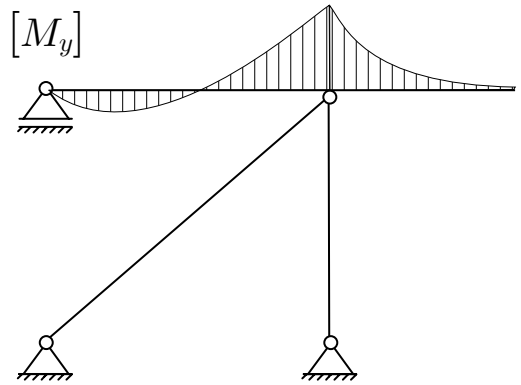
3. Ravnotežni pogoji za linijski element z ravno osjo (izpeljava diferencialnih enačb)! Ravnotežne pogoje izpeljite za raven ravninski nosilec, ki je obtežen samo z linijsko obtežbo prečno na os nosilca! Koliko je ravnotežnih enačb, ki niso identično zadoščene?

1. Naloga: PRAVILNI DIAGRAMI







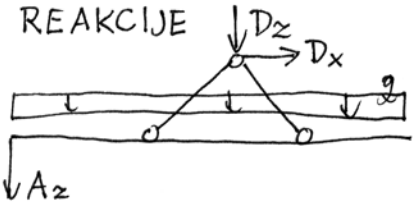


STATIKA - VSŠ 15. 9. 2005

2. NALOGA

a.) $\widehat{m}_{PS} = 3\cdot 3 - 2 - 1 - 3\cdot 2 = 0$

b.) REAKCIJE

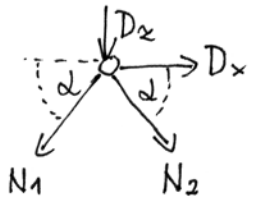


ΣX: $\boxed{D_x = 0}$

ΣZ: $A_z + D_z + g\cdot 3a = 0$ $\quad \boxed{A_z = 0}$

ΣM^A: $-g\cdot 3a\,\frac{3a}{2} - D_z\cdot\frac{3a}{2} = 0$ $\quad \boxed{D_z = -45\ kN}$

c.) SILE V PALICAH



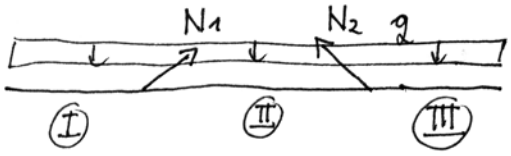
ΣX: $-N_1\cos\alpha + N_2\cos\alpha + D_x = 0 \Rightarrow N_1 = N_2$

ΣZ: $D_z + N_1\sin\alpha + N_2\sin\alpha = 0$

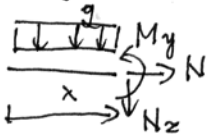
$N_1 = -\frac{D_z}{2\sin\alpha}$ $\quad \boxed{N_1 = N_2 = 25{\cdot}2\ kN}$

$tg\alpha = \frac{3}{1{\cdot}5} = 2$

d.) NOTRANJE SILE



polje (I)



Σx: $\boxed{N_x = 0}$

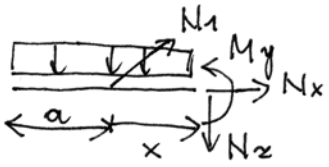
Σz: $N_z = -gx$

ΣM: $M_y = -gx\frac{x}{2}$

$\boxed{N_z = -5x}$ $\quad \boxed{N_z(3) = -15\ kN}$

$\boxed{M_y = -2{\cdot}5x^2}$ $\quad \boxed{M_y(3) = -22{\cdot}5\ kNm}$

polje (II) $\quad x\in[0,3]$



Σx: $N_x = -N_1\cos\alpha$

Σz: $N_z = -g(a+x) + N_1\sin\alpha$

ΣM: $M_y = -g(a+x)\frac{a+x}{2} + N_1\sin\alpha\, x$

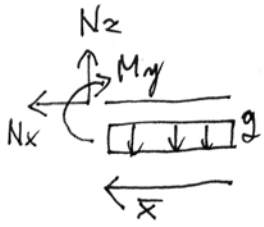
$\boxed{N_x = -11{\cdot}25\ kN}$ $\quad \boxed{N_z = 7{\cdot}5 - 5x}$

$\boxed{M_y = -22{\cdot}5 + 7{\cdot}5x - 2{\cdot}5x^2}$

$x = 1{\cdot}5$ (ekstrem)

$\boxed{M_y(1{\cdot}5) = -16{\cdot}8\ kNm}$

polje (III)

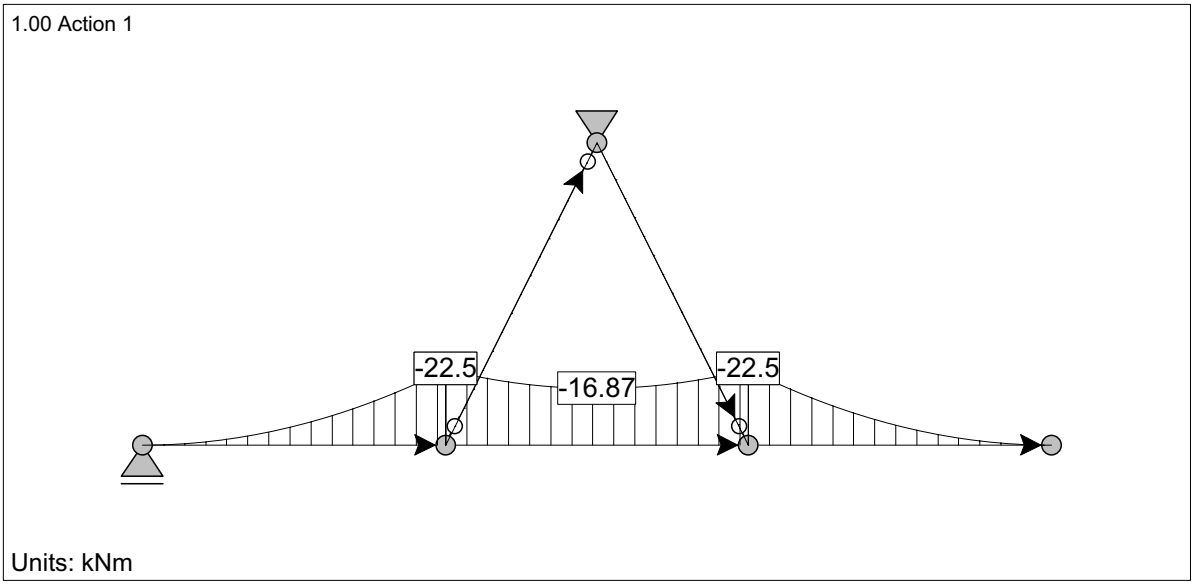


Σx: $\boxed{N_x = 0}$

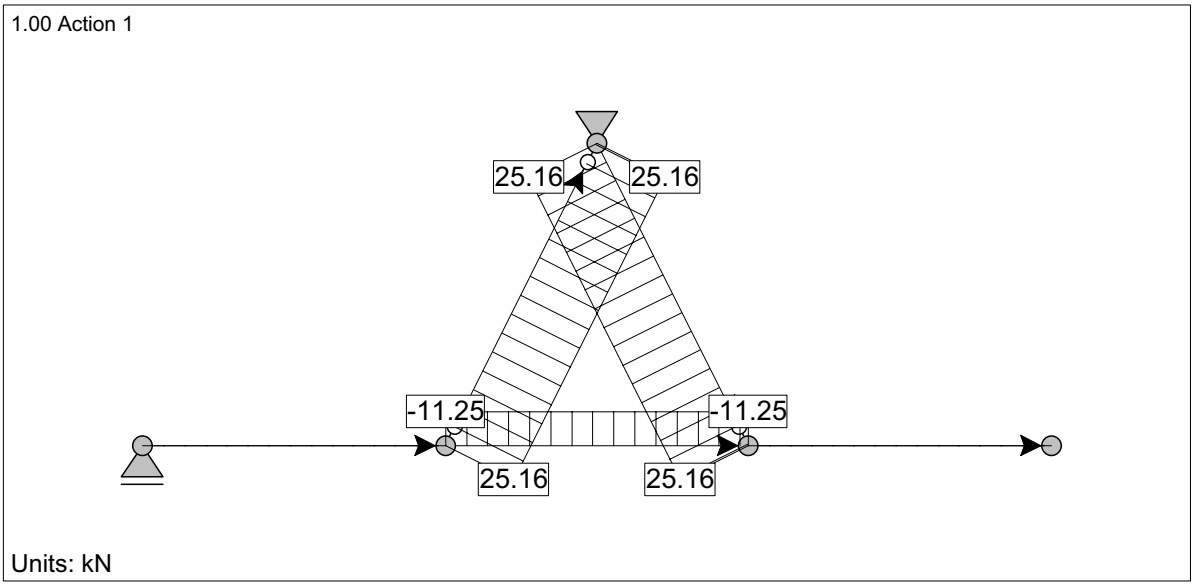
Σz: $N_z = g\bar{x}$ $\quad \boxed{N_z = 5\bar{x}}$

ΣM $M_y = -g\bar{x}\frac{\bar{x}}{2}$ $\quad \boxed{M_y = -2{\cdot}5\bar{x}^2}$

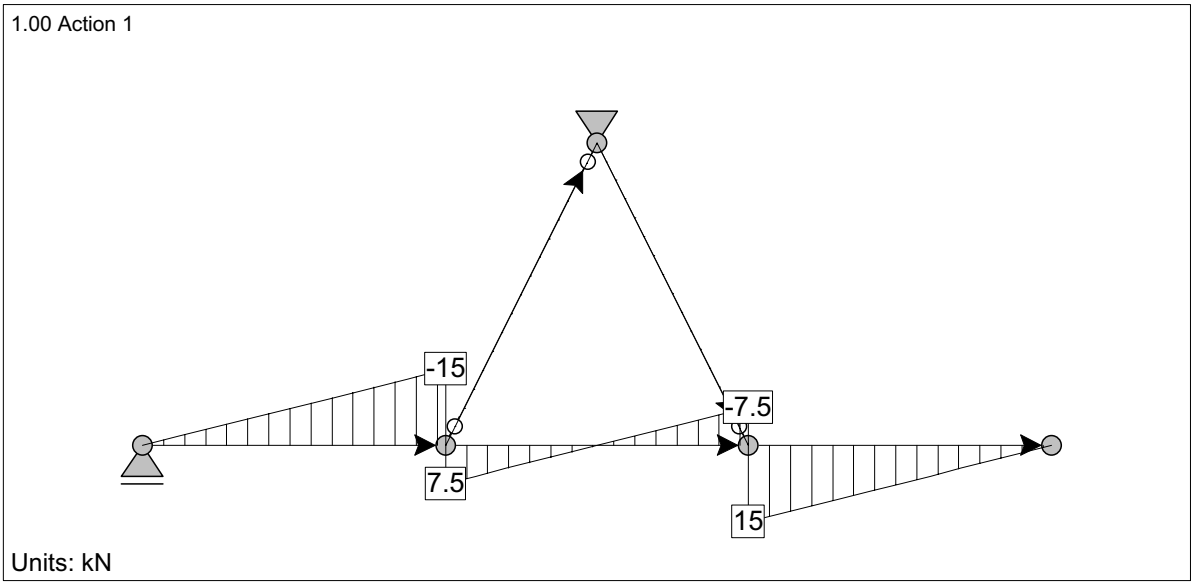
LC1: Load case 2: Bending Moments My



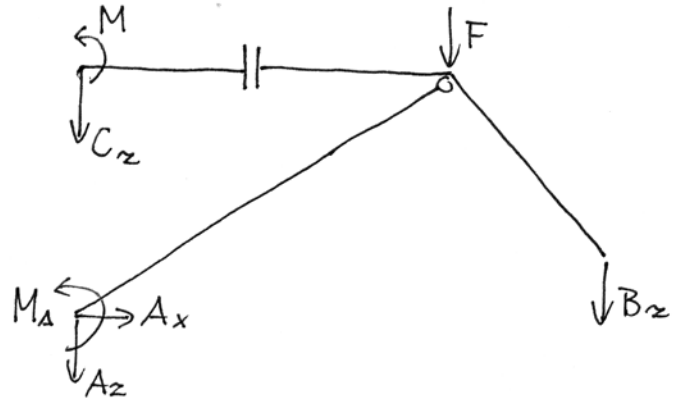
LC1: Load case 2: Axial Forces Fx



LC1: Load case 2: Shear Forces Fz



STATIKA - VSŠ 3. NALOGA 15. 9. 2005



ΣX: $\boxed{A_x = 0}$

ΣZ: $A_z + B_z + C_z + F = 0$

ΣM^A: $M_A - B_z 3a - F \cdot 2a + M = 0$

DODATNI ENAČBI

ΣZ: $\boxed{C_z = 0}$
CE

ΣM^D: $M_A + A_z \cdot 2a = 0 \Rightarrow -2a A_z + F 3a + A_z 3a - F 2a + M = 0$
AD

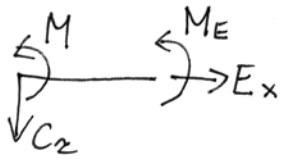
$\boxed{A_z = -11\,kN}$

$\boxed{B_z = +1\,kN}$

$\boxed{M_A = +44\,kNm}$

b.) VEZI

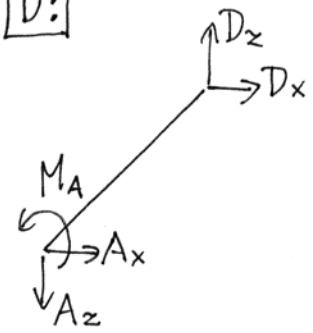
E:



$\boxed{E_x = 0}$

$M_E = -M - C_z \cdot a$ $\boxed{M_E = -2\,kNm}$

D:



ΣX: $D_x = -A_x$ $\boxed{D_x = 0}$

ΣZ: $D_z = A_z$ $\boxed{D_z = 11\,kN}$

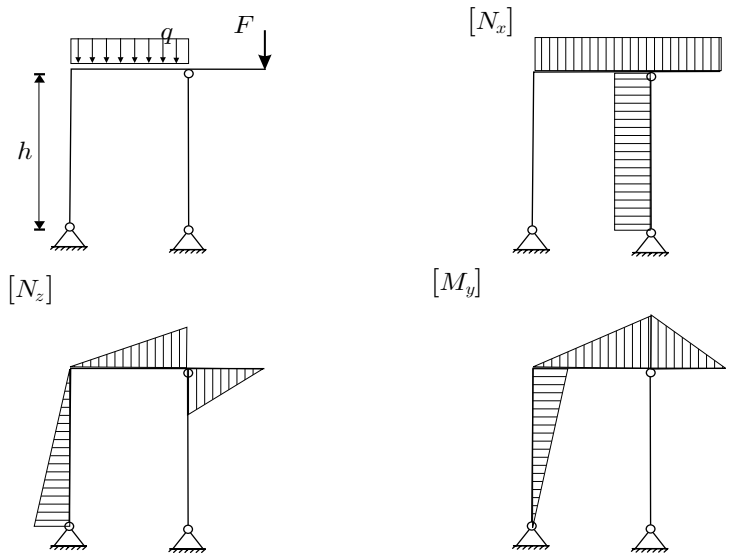
KONTROLA

ΣM^A: $M_A - D_z \cdot 2a = 0$ ✓

STATIKA (VSŠ) - 2. IZREDNI IZPITNI ROK (7. 12. 2005)

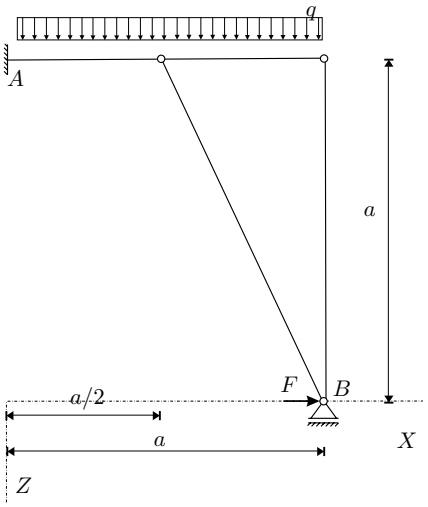
RAČUNSKI DEL IZPITA:

1. Janezek je na izpitu iz statike padel. Njegovi diagrami so polni napak. Pomagaj Janezku in poišči (BREZ RAČUNANJA) vse napake v spodnjih diagramih ! (OBVEZNA NALOGA! 25%)



. . . . . .

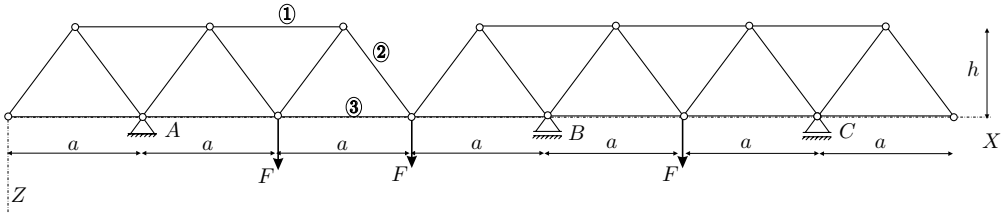
2. Za konstrukcijo na sliki izračunajte stopnjo statične nedoločenosti, reakcije in notranje statične količine (N_x, N_z, M_y)! Rezultate notranjih statičnih količin prikažite z diagrami! (OBVEZNA NALOGA! 45%)
Podatki: $a = 3\,\mathrm{m}$,
$q = 10\,\mathrm{kN/m}$, $F = 20\,\mathrm{kN}$.
(OBVEZNA NALOGA! 45%)



. . . . . .

3. Za palično konstrukcijo na sliki določite (BREZ RAČUNANJA) palice, v katerih je osna sila 0, izračunajte stopnjo statične nedoločenosti in osne sile v palicah 1, 2 in 3! (30%)

Podatki: $a = 3\,\mathrm{m}$, $h = 2\,\mathrm{m}$, $F = 10\,\mathrm{kN}$.



TEORETIČNI DEL IZPITA:

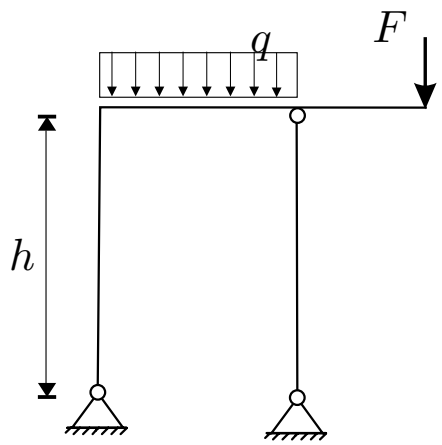
Izmed treh zastavljenih vprašanj si izberete dve, na kateri boste odgovarjali. Izbrani vprašanji jasno označite! Pišite čitljivo.

1. Definicija števila prostostnih stopenj (ilustracija z značilnimi primeri: gibanja delca po ravnini, gibanje N delcev po ravnini, gibanje togega telesa v prostoru, gibanje N togih teles, ki imajo skupno poljubno vez)!

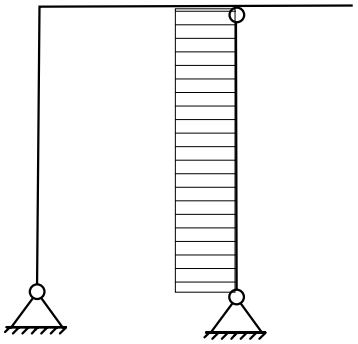
2. Izpeljite ravnotežne pogoje za sile, ki delujejo na sistem delcev s togimi vezmi! Pokaži, da sta izpeljana ravnotežna pogoja potrebna in zadostna pogoja za ravnotežje sistema sil na sistemu sil s togimi vezmi!

3. Račun osnih sil v ravninskem paličju! (Opišite vse metode in jih ilustrirajte s primeri! Zapišite samo ustrezne ravnotežne enačbe, brez računa!)

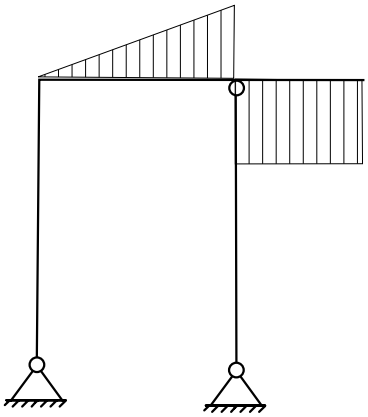
1. Naloga: PRAVILNI DIAGRAMI



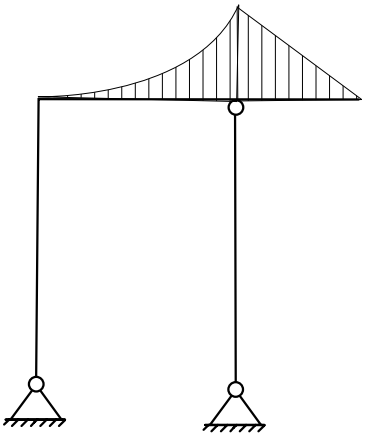
$[N_x]$



$[N_z]$



$[M_y]$

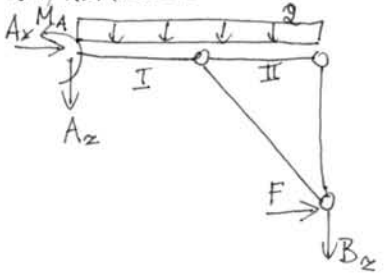


STATIKA – VSŠ 7. 12. 2005

2. NALOGA

a.) $\tilde{n}_{PS} = 4 \cdot 3 - 3 - 1 - \cdot 2 \cdot 2 - 2 \cdot 2 = 0$

b.) REAKCIJE

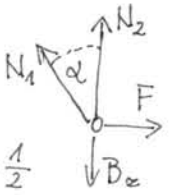


$\Sigma X: A_x + F = 0 \quad \boxed{A_x = -F}$

$\Sigma Z: A_z + B_z + g \cdot a = 0$

$\Sigma M^A: M_A - g \cdot a \cdot \frac{a}{2} + F \cdot a - B_z \cdot a = 0$

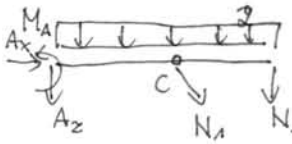
DODATNE ENAČBE: IZREŽEMO PALICI



$tg\,\alpha = \frac{1}{2}$

$\Sigma x: N_1 \cdot \sin\alpha = F$

$\Sigma z: N_1 \cdot \cos\alpha + N_2 = B_z$



$\Sigma M^C: -N_2 \frac{a}{2} - g \frac{a}{2} \cdot \frac{a}{4} = 0$

$N_2 = -g \cdot \frac{a}{4} \Rightarrow \boxed{N_2 = -7{,}5\ kN}$

$N_1 = \frac{F}{\sin\alpha} \Rightarrow \boxed{N_1 = 44{,}7\ kN}$

$\boxed{A_x = -20\ kN}$

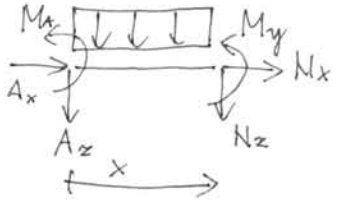
$\boxed{B_z = 32{,}5\ kN}$

$\boxed{A_z = -62{,}5\ kN}$

$\boxed{M_A = 82{,}5\ kNm}$

c.) NOTRANJE SILE

(I)



$\boxed{N_x = 20\ kN}$

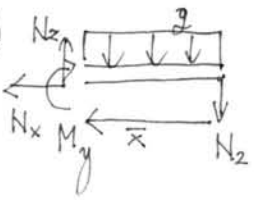
$N_z = -A_z - g x$

$M_y = -M_A - A_z x - g x \frac{x}{2}$

$\boxed{N_z = 62{,}5 - 10x}$

$\boxed{M_y = -82{,}5 + 62{,}5x - 5x^2}$

(II)



$\boxed{N_x = 0}$

$N_z = N_2 + g\bar{x}$

$M_y = -N_2\bar{x} - g\frac{\bar{x}^2}{2}$

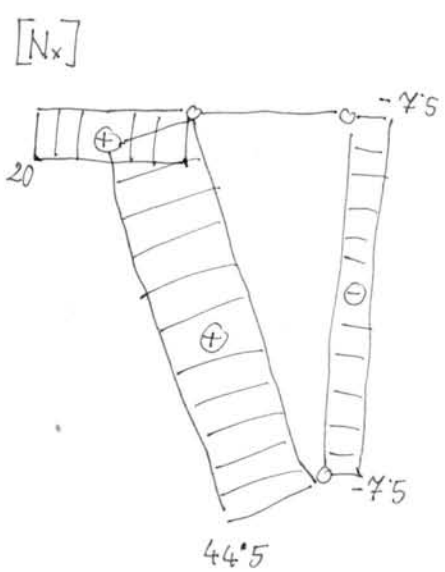
$\boxed{N_z = -7{,}5 + 10\bar{x}}$

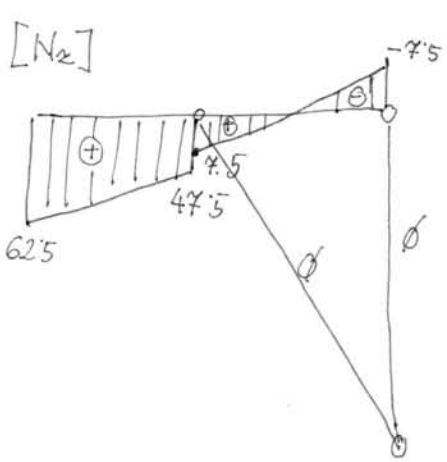
$\boxed{M_y = 7{,}5\bar{x} - 5\bar{x}^2}$

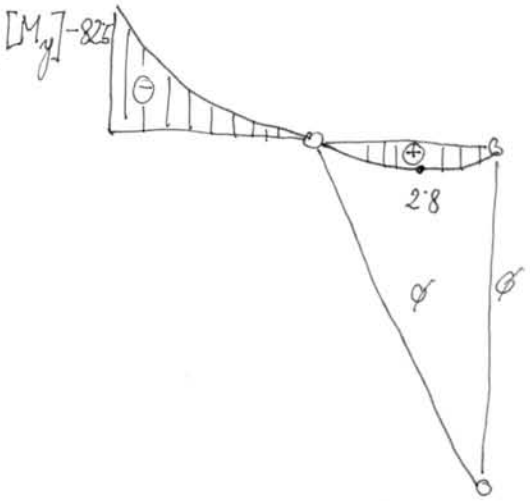
$N_z(1{,}5) = 15 - 7{,}5 = 7{,}5\ kN$

$M_y(0{,}75) = 2{,}8\ kNm$ (ekstrem)

d.) DIAGRAMI







STATIKA - VŠŠ 7. 12. 2005

3. NALOGA

a.) $\tilde{n}_{PS} = 2 \cdot 12 + 1 + 1 - 26 = 0$

b.) REAKCIJE

ΣX: $\boxed{A_x = 0}$

ΣZ $A_z + B_z + C_z + 3F = 0$

ΣM^A: $-F \cdot a - F \cdot 2a - B_z \cdot 3a - F \cdot 4a - C_z 5a = 0$

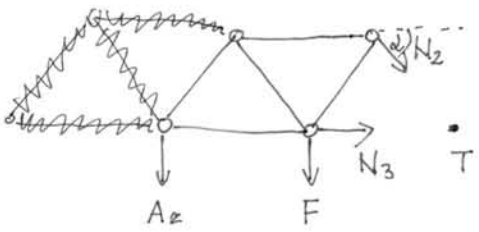
$B_z + C_z = -25$

$3B_z + 5C_z = -70$

dodatna enačba

ΣM^T: $Fa + A_z \cdot 2a = 0$ $\quad \boxed{A_z = -\frac{F}{2}} \quad \boxed{A_z = -5\,kN}$

B_z in C_z sploh ne potrebujemo!

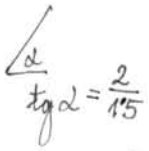


ΣX: $N_3 + N_2 \cos\alpha = 0$

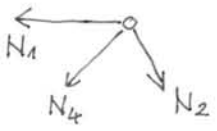
ΣZ: $N_2 \sin\alpha + F + A_z = 0 \Rightarrow$

$\boxed{N_3 = \frac{F}{2} \cdot \operatorname{ctg}\alpha = 3{,}75\,kN}$

$\boxed{N_2 = -\frac{F}{2\sin\alpha} = -6{,}25\,kN}$



izrežemo vozlišče



Σx: $-N_1 - N_4 \cdot \cos\alpha + N_2 \cdot \cos\alpha = 0$

ΣZ: $N_4 \cdot \sin\alpha + N_2 \cdot \sin\alpha = 0 \Rightarrow N_4 = -N_2$

$N_1 = 2N_2 \cos\alpha$

$\boxed{N_1 = -7{,}5\,kN}$