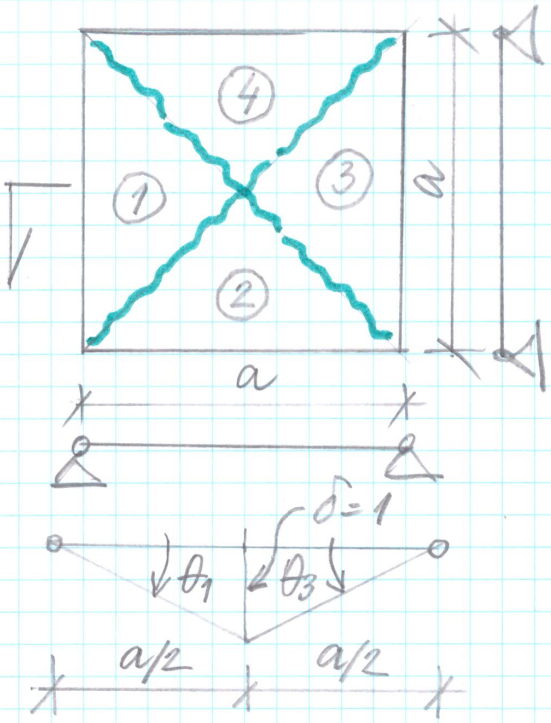
PRIMER 7



* $M_{pl}(x) = M_{pl}(y) = M_{pl}(\alpha) = M_{pl}$
* JEDNAKO PODELJENO OPTEREĆENJE PO CELOJ POVRŠINI $i = 1, 2, 3, 4$

$$\theta_1 = \theta_2 = \theta_3 = \theta_4 = \frac{1}{\frac{a}{2}} = \frac{2}{a}$$

$$RUS = \left(\sum_i \left[\theta_i \left(\sum_k M_{pl,k} \cdot (l_k \cdot \cos\varphi_k)\right)\right]\right)$$

$$= 4 \times \left[\frac{2}{a}\left(M_{pl} \cdot \frac{a}{2} + M_{pl} \cdot \frac{a}{2}\right)\right]$$

$$RUS = 8 M_{pl}$$

$$RSS = \frac{1}{3} a^2 \cdot q$$

$$RUS = RSS \rightarrow$$

$$q = q_{Rd} = \underline{24} \frac{M_{pl}}{a^2} \quad \xrightarrow{M_{Rd}} \text{(AKO SE ODREĐUJE NOSIVOST)}$$

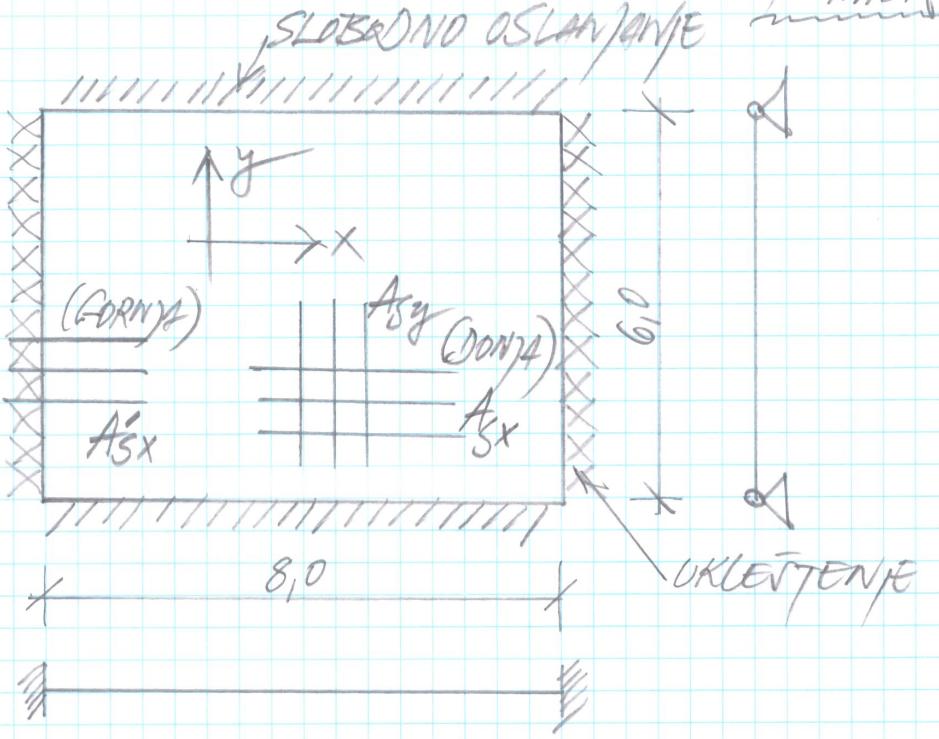
ILI

$$M_{Ed} = \underline{0{,}042} \cdot q_{Ed} \, a^2 \quad \text{(AKO SE RAČUNAJU PRESEČNI UTICAJI)}$$

PRORAČUN PO TEORIJI ELASTIČNOSTI DAJE:

$$M_{Ed} = \underline{0{,}048} \, q_{Ed} \cdot a^2 \quad \text{ODAKLE:} \quad q_{Rd} = \underline{20{,}8} \frac{M_{Rd}}{a^2}$$

PRIMER 8/1



ZA PRIKAZANU PLOČU ODREDITI GRANIČNU NOSIVOST PRIMENOM LINIJA LOMA.
OPTEREĆENJE JE JEDNAKO PODELJENO PO ČITAVOJ POVRŠINI
PODACI ZA PRORAČUN:

$M_{pe}(A_{sx}) = M_{pe}(x) = M_{pe}(A_{sy}) = M_{pe}(y) = M_{pe}$

$\longrightarrow M_{pe}(\alpha) = M_{pe}(x)\cos^2\alpha + M_{pe}(y)\sin^2\alpha = M_{pe}$
(DONJA ZONA)

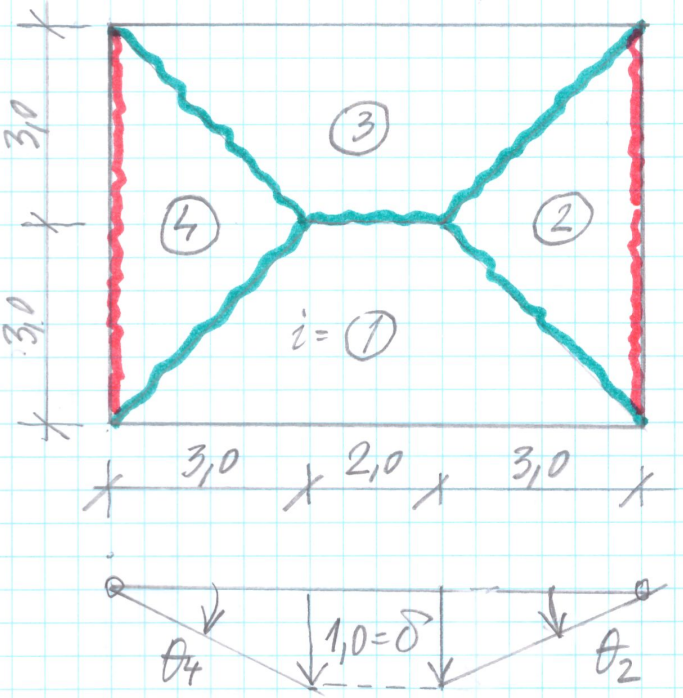
$M_{pe}(A_{sx}') = M_{pe}'(x) = 2M_{pe}\ (A_{sx}' \approx 2A_{sx})$

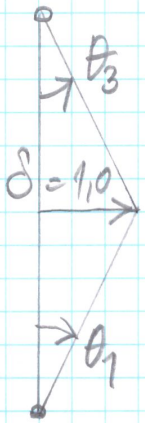
$M_{pe}(A_{sy})$ – NIJE POTREBAN ZA PRORAČUN
(GORNJA ZONA)

PRORAČUN ĆE SE URADITI SA VIŠE MEHANIZAMA JER METODA NIJE NA STRANI SIGURNOSTI

1. MEHANIZAM

* KORISTIMO SIMETRIČNOST PRI POSTULIRANJU
* ~~~ "POZITIVNA" LINIJA LOMA - ZATEGNUTA DONJA ARMATURA
* ~~~ "NEGATIVNA" LINIJA LOMA - ZATEGNUTA GORNJA ARMATURA





MOMENTI PLASTIČNOSTI

ZA ~~~ M_{pl}

ZA ~~~ $M_{pl}' = 2M_{pl}$

$\theta_1 = \theta_3 = \frac{1}{3,0}$

$\theta_2 = \theta_4 = \frac{1}{3,0}$

$$RUS = 2 \times \left\{ \frac{1}{3,0}(3,0+2,0+3,0)M_{pl} + \frac{1}{3,0}\left[(3,0+3,0)M_{pl} + 6,0(2M_{pl})\right] \right\}$$

OD SVAKE PLOČE IMA 2 (1), (3) (2), (4)

$$RUS = \frac{52}{3} M_{pl}$$

$$RSS = q \cdot \left[2 \cdot \frac{1}{3} \cdot 3,0 \cdot 6,0 \cdot 1,0 + \frac{1}{2} 6,0 \cdot 2,0 \cdot 3,0 \right] = 18q$$

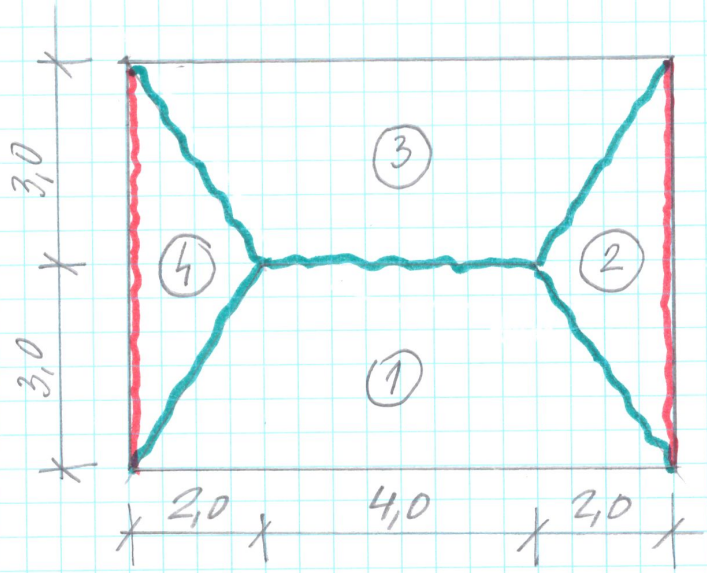
2 PIRAMIDE, PRIZMA

$RUS = RSS$: $\frac{52}{3} M_{pl} = 18q \rightarrow$

$$q_1 = \frac{52}{54} M_{pl} = 0,96 M_{pl}$$

(1. MEHANIZAM)

2. MEHANIZAM



M_{pl}

$2M_{pl}$

$\theta_1 = \theta_3 = \frac{1}{3,0}$

$\theta_2 = \theta_4 = \frac{1}{2,0}$

$$RUS = 2 \cdot \left\{ \frac{1}{3,0} \cdot 8,0 \cdot M_{pl} + \frac{1}{2,0} \left[6,0 M_{pl} + 6,0 \cdot (2 M_{pl}) \right] \right\}$$

$$RUS = \frac{70}{3} M_{pl}$$

$$RSS = q \cdot \left[2 \cdot \frac{1}{3} \cdot 6,0 \cdot 2,0 \cdot 1,0 + \frac{1}{2} \cdot 4,0 \cdot 6,0 \cdot 1,0 \right]$$

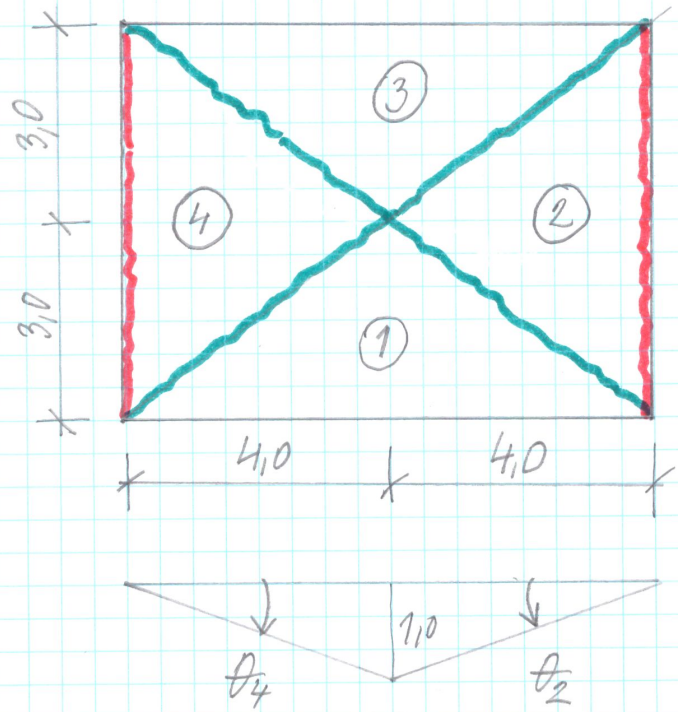
$$RSS = 20q$$

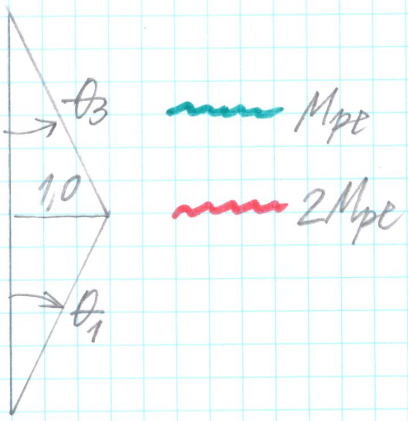
$$RUS = RSS: \quad \frac{70}{3} M_{pl} = 20q \rightarrow \boxed{q_2 = \frac{70}{60} M_{pl} = 1,17 M_{pl}}$$

(2. MEHANIZAM)

PRVI MEHANIZAM JE IZMENJEN U POVOLJNIJU STRANU ($q_2 > q_1$) !!

3. MEHANIZAM





$$\theta_1 = \theta_3 = \frac{1}{3,0}$$

$$\theta_2 = \theta_4 = \frac{1}{4,0}$$

$$RUS = 2 \cdot \left\{ \frac{1}{3,0} \cdot 8,0 \cdot M_{pe} + \frac{1}{4,0} \left[6,0 \cdot M_{pe} + 6,0 \cdot (2M_{pe}) \right] \right\}$$

$$RUS = \frac{43}{3} M_{pe}$$

$$RSS = q \cdot \frac{1}{3} \cdot 8,0 \cdot 6,0 = 16q$$

$$RUS = RSS : \frac{43}{3} M_{pe} = 16q \rightarrow \boxed{q_{13} = \frac{43}{48} M_{pe} = 0,90 M_{pe}}$$

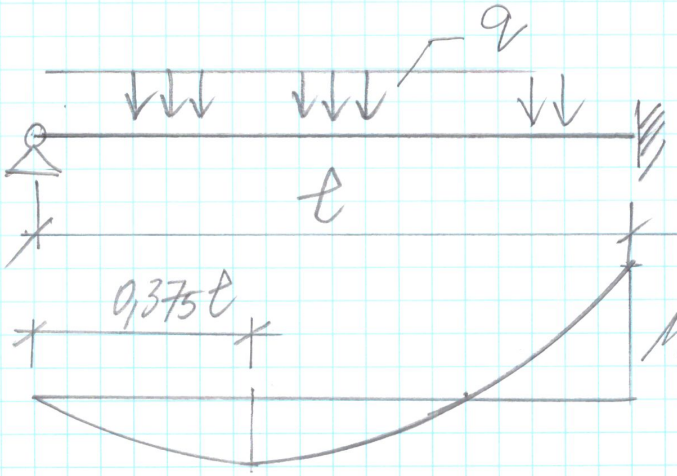
(3. MEHANIZAM)

OVAJ REZULTAT JE NAJBOLJI DO SADA:

$$q_3 = \min \{ q_1, q_2, q_3 \}$$

PITANJE: MOŽE LI BOLJE (MANJE)?

PRIMER 9/1

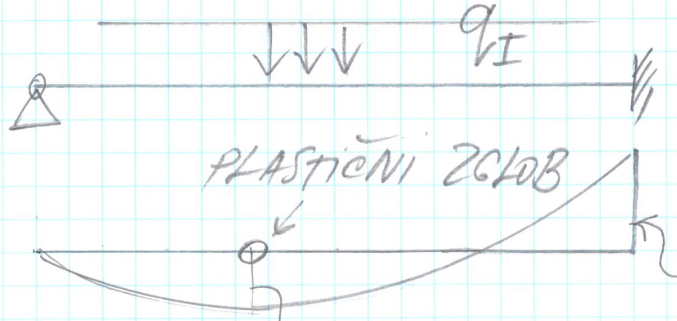


$M_{polje} = \frac{9}{128} q l^2$

$\frac{M_{osl}}{M_{polje}} = 1{,}78$

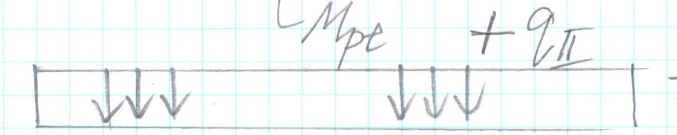
1. SLUČAJ: NEKA $A_s' = 2A_s$ ($M_{pe}' \approx 2 M_{pe}$) POLJE

(OSLONAC)



NIVO OPTEREĆENJA ZA I ZGLOB

$M_I' = 1{,}78 M_{pe} < M_{pe}'$

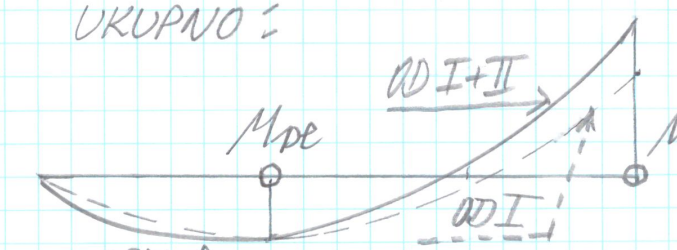


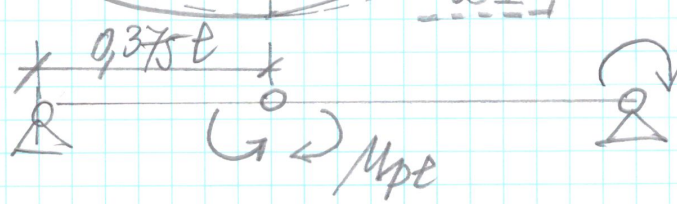
+ JOŠ OPTEREĆENJA

M_{II}' TAKO DA

$M_I' + M_{II}' = M_{pe}'$

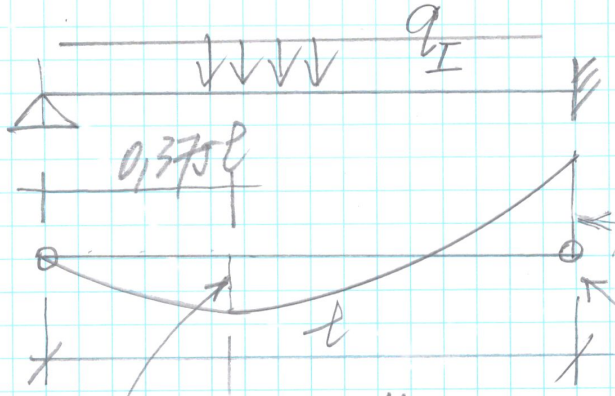
UKUPNO:





MEHANIZAM

2. SLUČAJ: NEKA $A_f' = A_s$ ($M_{pe}' = M_{pe}$) 9/2

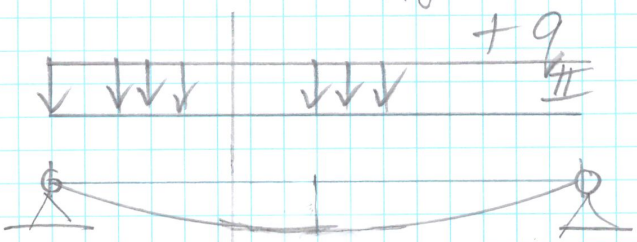


NIVO OPTEREĆENJA ZA PRVI ZGLOB

$M = M_{pe}' = M_{pe}$

PLASTIČNI ZGLOB

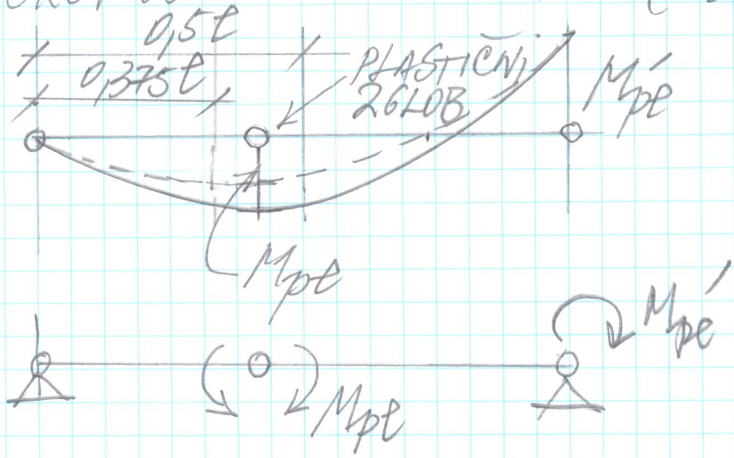
$M = \frac{M_{osℓ}}{1,78} < M_{pe}$



+ JOŠ OPTEREĆENJA

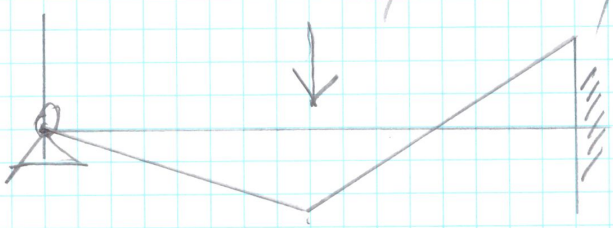
M_{II} TAKO DA $M_I + M_{II} = M_{pe}$ (NEGDE U POLJU)

UKUPNO:



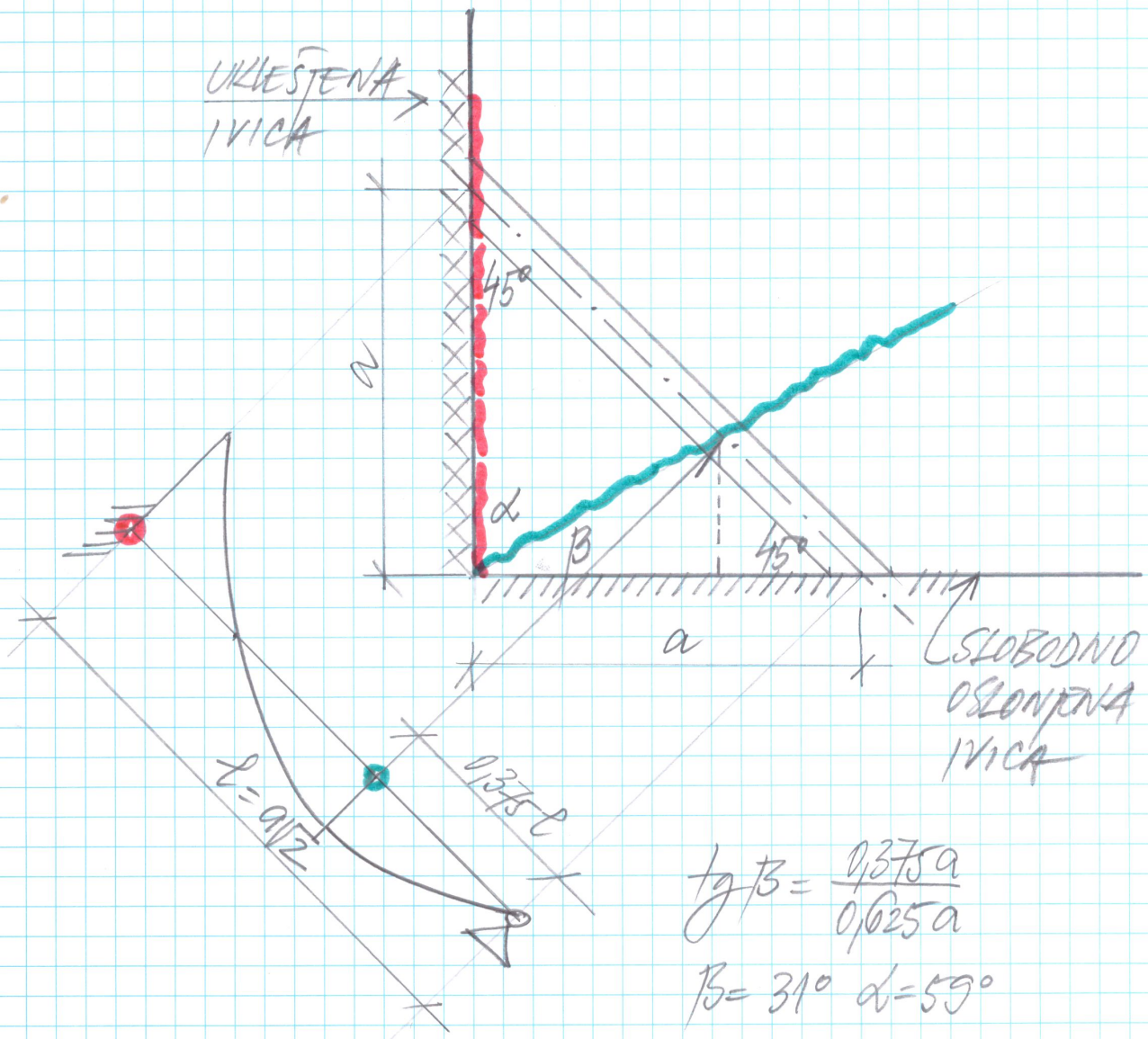
ZGLOB NIJE NA ISTOM MESTU KAO U 1. SLUČAJU – POMEREN JE KA SREDINI

3. SLUČAJ: KONCENTRISANO OPTEREĆENJE



ZGLOB JE NA MESTU SILE I U UKLJEŠTENJU

SLIKA 10



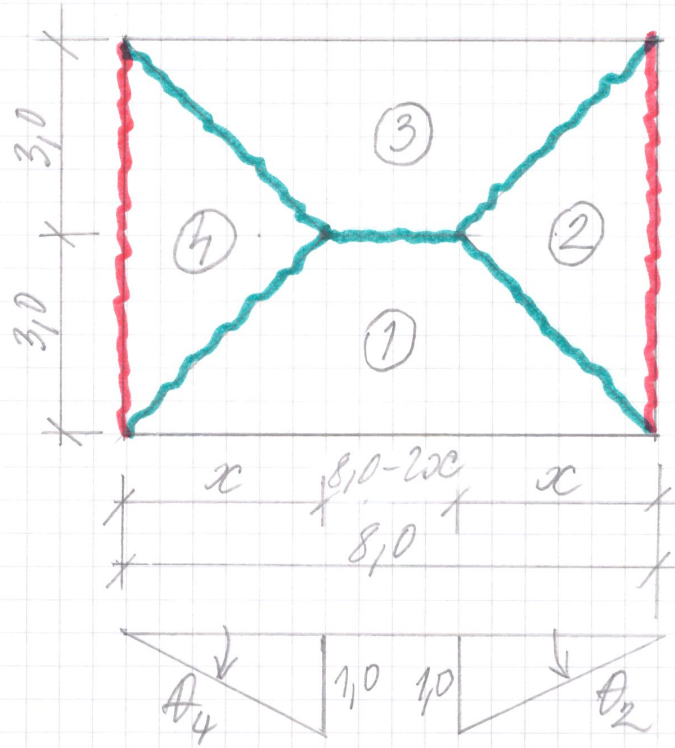
$$tg\,\beta = \frac{0{,}375\,a}{0{,}625\,a}$$

$\beta = 31°$ $\alpha = 59°$

KADA JE UKLEŠTENA IVICA I SLOBODNO OSLONJENA IVICA SUSTIČU U (PRAVOM) UGLU POZITIVNA LINIJA LOMA DELI UGAO U PRIBLIŽNOM ODNOSU 60°-30° (30° DO SLOBODNO OSLONJENE IVICE)

PRIMER 11/1

* PLOČA IZ PRIMERA 8
REŠAVA SE SA "UOPŠTENIM" MEHANIZMOM — MEHANIZMOM KOJI JE OPISAN PROMENLJIVOM



MOMENTI PLASTIČNOSTI
2A ~~~ M_{pl}
2A ~~~ $M_{pl}' = 2M_{pl}$

$\theta_1 = \theta_3 = \frac{1}{3,0}$

$\theta_2 = \theta_4 = \frac{1}{x}$

$$RUS = 2M_{pl}\left\{\frac{8}{3} + \frac{18}{x}\right\}$$

$$RSS = 2q(12-x)$$

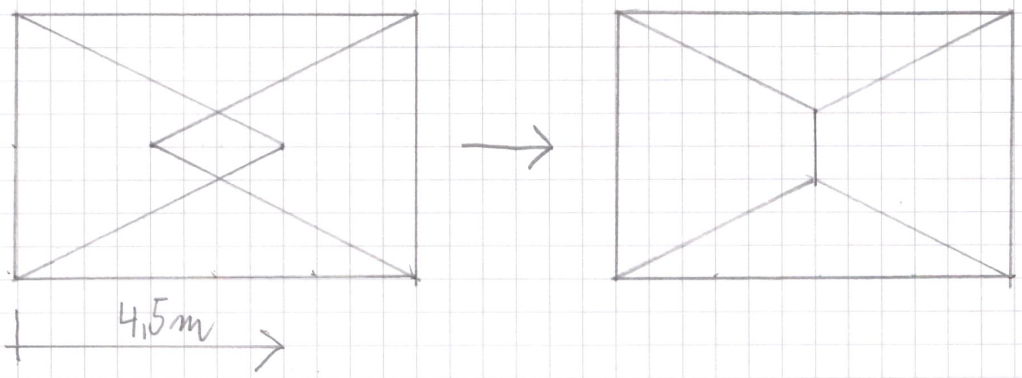
$$RUS = RSS \longrightarrow q = \frac{8x+54}{3x(12-x)} M_{pl}$$

ODAKLE MOŽE, PROBANJEM, $x = \_, \_, \ldots \rightarrow q_{min}$

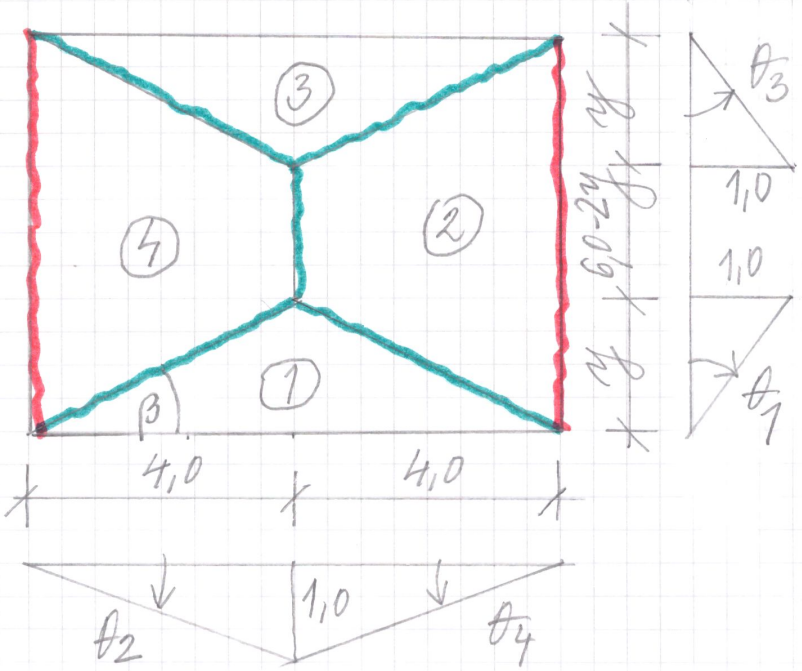
ILI: $\frac{\partial q}{\partial x} = 0 \rightarrow x \rightarrow q_{min}$

PROBANJEM, ZA $x = 4,5\,m \rightarrow q = 0,89\,M_{pl}$
ŠTO JE MANJE OD $q_3 = 0,90\,M_{pl}$!
ALI $x \leq 4,0\,m$ FIZIČKI → OBLIK FIGURE LOMA NIJE OPTIMALAN!

11/2



PRETPOSTAVLJAMO NOVU FIGURU LOMA



$\theta_1 = \theta_3 = \frac{1}{y}$

$\theta_2 = \theta_4 = \frac{1}{4,0}$

M_{pe}

$M_{pe}' = 2M_{pe}$

$$RUS = 2 \cdot \left\{ \frac{1}{y} 8,0 M_{pe} + \frac{1}{4,0} \left[6,0 \cdot M_{pe} + 6,0 (2M_{pe}) \right] \right\} = M_{pe} \left(\frac{16}{y} + 9 \right)$$

$$RSS = q \left[2 \cdot \frac{1}{3} \cdot 8,0 \cdot y \cdot 1,0 + \frac{1}{2} (6,0 - 2y) \cdot 8,0 \cdot 1,0 \right] = \frac{8}{3} (9 - y) q$$

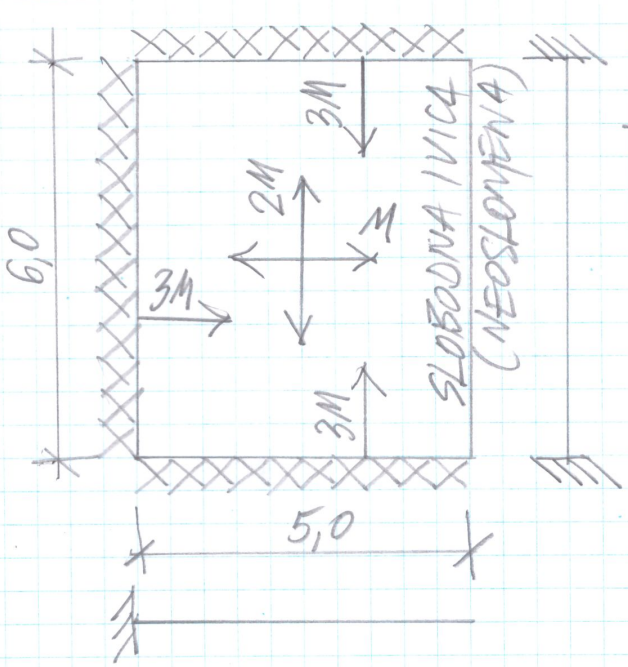
$$q = \frac{3}{8} \cdot \frac{9y + 16}{9y - y^2} M_{pe} \; ; \quad \frac{\partial q}{\partial y} = 0 \rightarrow y = 2,60 m$$

$$q_{min} = 0,888 M_{pe}$$

$$(tg\beta = \frac{2,60}{4,0} = 0,65 \rightarrow \beta = 33°)$$

PRIMER 14/1

ZA PRIKAZANU ORTOTROPNU PLOČU ($M_{pc}(x) \neq M_{pc}(y)$) I USVOJENU FIGURU LOMA SRAČUNATI VELIČINU JEDNAKO PODELJENOG GRANIČNOG OPTEREĆENJA KOJE DELUJE PO ČITAVOJ POVRŠINI.



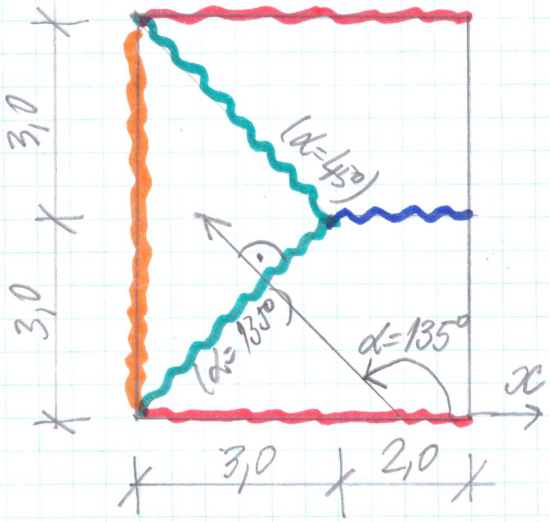
$M_{pc}(x) = M$

$M_{py}(y) = 2M$

$M_{pć}(x) = 3M$

$M_{pć}(y) = 3M$

1. NAČIN – DIREKTNA PRIMENA OPŠTEG POSTUPKA



$M_{pc} = M_{pc}(y) = 2M$

$M_{pc}(\alpha = 135°) =$

$= M_{pc}(x)\cos^2 135° + M_{pc}(y)\sin^2 135$

$= M \cdot (\sqrt{2}/2)^2 + 2M(\sqrt{2}/2)^2$

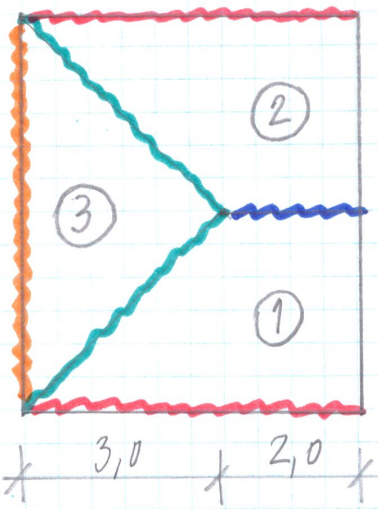
$= 3/2\, M$

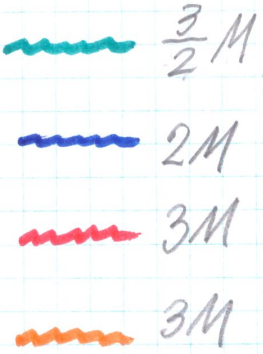
$M_{pc}(\alpha = 45°) = 3/2\, M$

$M_{pć}(y) = 3M$

$M_{pć}(x) = 3M$

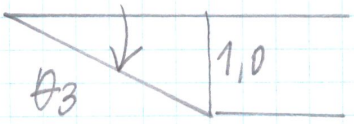
MEHANIZAM I





$\theta_1 = \theta_2 = \frac{1}{3,0}$

$\theta_3 = \frac{1}{3,0}$



$$RUS = \underset{①,②}{2} \cdot \left[\frac{1}{3,0} \left(3,0 \cdot \frac{3}{2}M + 2,0 \cdot 2M + 5,0 \cdot 3M \right) \right] +$$

$$+ \underset{③}{\frac{1}{3,0}} \left(3,0 \cdot \frac{3}{2}M + 3,0 \cdot \frac{3}{2}M + 6,0 \cdot 3M \right)$$

$$RUS = \frac{74}{3} M$$

$$RSS = q \left[\frac{1}{3} 3,0 \cdot 6,0 \cdot 1,0 + \frac{1}{2} 2,0 \cdot 6,0 \cdot 1,0 \right] = 12q$$

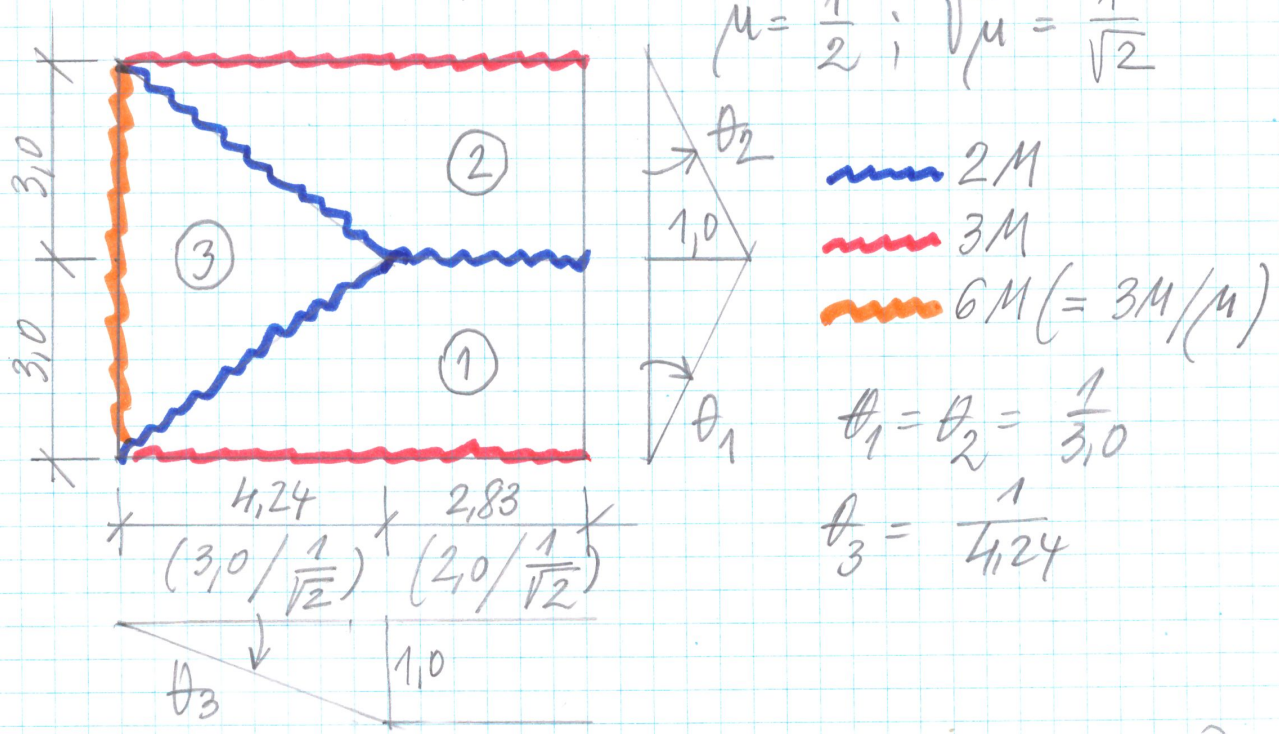
$$RUS = RSS \longrightarrow \boxed{q = \frac{74}{36} M = 2,056 M}$$

2. NAČIN – AFINA TRANSFORMACIJA

$$\mu = \frac{M_{pe(x)}}{M_{pe(y)}} = \frac{M}{2M} = \frac{1}{2}$$

(JAKO $\frac{M_{pé(x)}}{M_{pé(y)}} = \frac{3M}{3M} = 1 \neq \mu$ PRIMENA JE MOGUĆA JER SU SVE NEGATIVNE LINIJE X ILI y)

AFINA PLOČA:



$$\mu = \frac{1}{2}\ ;\ \sqrt{\mu} = \frac{1}{\sqrt{2}}$$

$$\theta_1 = \theta_2 = \frac{1}{3,0}$$

$$\theta_3 = \frac{1}{4,24}$$

$$RUS = \underset{①②}{2} \cdot \left\{ \frac{1}{3,0}\left[(4,24+2,83)2M + 7,07 \cdot 3M\right] \right\}$$

$$+ \underset{③}{\frac{1}{4,24}}\left(6,0 \cdot 2M + 6,0 \cdot 6M\right) = 34,89\,M$$

$$RSS = q\left[\frac{1}{3}4,24 \cdot 6,0 \cdot 1,0 + \frac{1}{2}2,83 \cdot 6,0 \cdot 1,0\right] = 16,97\,q$$

$$RUS = RSS \rightarrow \boxed{q = \frac{34,89}{16,97}M = 2,056M}$$